FIXED-WING AIR SUPPORT PLANNING MODELS FOR THE BRIGADE COMBAT TEAM

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ABSTRACT

FIXED-WING AIR SUPPORT PLANNING MODELS FOR THE BRIGADE COMBAT TEAM (BCT), by Lt Col Scott C. Campbell, 98 pages.

The Army's transformation to the brigade combat team (BCT) as its primary combat employment unit has come at the cost of reduced organic firepower and armor under the modular force concept. As a result, greater emphasis and dependence will likely be placed upon fixed-wing fires in support of the BCT. Simultaneously, Air Force aircraft continue to experience reduced mission capable (MC) rates due to sustained combat operations and airframe fatigue. The Air Force is acquiring new tactical airframes while recapitalizing and retiring others, but at a projected rate less than a 1:1 replacement ratio. Presented in this thesis is an integrated force ratio model to quantify both Army requirements and Air Force capacity to support those requirements. A modified case study using Desert Storm provides a context for the practical application of this model in determining future force requirements for both services and to answer the primary research question: Can the Air Force provide sufficient support to the BCTs engaged in major combat operations (MCO)? Recommendations include re-evaluating Army modularity assumptions for non-organic joint fires support as well as a dedicated, combined approach between the Air Force and Army to jointly evaluate force structure and acquisition decisions.

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This thesis is dedicated to all of those who are part of the joint fires team--those who are able to put aside service parochialisms and politics in an effort to more efficiently and effectively support the troops on the ground. I hope this work will continue to improve the integration between the Air Force and the Army in an effort to better support those forces in harm's way.

I would like to thank the members of my committee for their assistance and guidance in the development of this thesis. Colonel John Cherrey, Director of the Air Force Element at CGSC, not only served as the chair for the committee but provided great inputs that allowed me to decide on the topic and eventually refine it to its current form. Mr. Raun Watson of CTAC provided continuous timely and constructive feedback as well as expert inputs on tactical aspects from the Army perspective. Dr. Jim Martin was able to make time even as the Associate Dean of Academics to give me quick point outs or vectors on my research methodology whenever I sought them. All three instructors gave up invaluable time and effort to see this project to completion.

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ACRONYMS

AAGS	Army Air Ground System
A/C	Aircraft
AF	Air Force
AGM	Air-to-Ground Missile
AI	Air Interdiction
ATP	Advanced Targeting Pod
BCL	Battlefield Coordination Line
BCT	Brigade Combat Team
BCTP	Battle Command Training Program
BN	Battalion
CAB	Combined Arms Battalion
CAF	Combat Air Forces
CAS	Close Air Support
CGSC	Command and General Staff College
COIN	Counter-Insurgency
FCS	Future Combat System
FE	Force Equivalent
FEBA	Forward Edge of the Battle Area
FLOT	Forward Line of Troops
FSCL	Fire Support Coordination Line
GBU	Guided Bomb Unit
HBCT	Heavy Brigade Combat Team
IAM	Inertially-Aided Munition

IBCT	Infantry Brigade Combat Team
JDAM	Joint Direct Attack Munition
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JFLCC	Joint Force Land Component Commander
KI	Kill box Interdiction
MCO	Major Combat Operations
PAA	Primary Aircraft Authorized
SBCT	Stryker Brigade Combat Team
SCAR	Strike Coordination and Reconnaissance
SCL	Standard Conventional Load
TACS	Theater Air Control System

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CHAPTER 1

INTRODUCTION

Background

The U.S. Army underwent an extensive transformation of its force structure in recent years. During this time, the primary unit of employment changed from the division to the brigade combat team (BCT). While the brigade previously existed under the force structure of the division, it was heavily dependent on organic forces within the division and rarely fought or deployed as an autonomous or individual unit. As a result of this operational separation from the division, the BCT became more self-sufficient than its predecessor, gaining additional organic capabilities including the fires, reconnaissance, surveillance and target acquisition (RSTA), and support battalions. Another goal of transformation was to make the BCT lighter, faster and more agile. In order to do this, the Army accepted risk in the form of less organic armor and artillery in the BCT. In the case of artillery, the BCT operates with as much as 20 percent less artillery and multiple launch rocket systems (MLRS) and 60 percent less "heavy" artillery.[1] As part of the modular concept, the Army will eliminate 26 field artillery battalions.[2] With regards to armor, the Army plans to cut 19 armor battalions from its force structure with a simultaneous increase to 76 BCTs.[3]

As the Army instituted sweeping changes in its force structure, the Air Force simultaneously struggled with force structure issues of its own. Unlike the Army, the Air Force issues are centered on the health of the fleet; both the acquisition of new systems including the F-22 and F-35 and the recapitalization of existing platforms that are beyond the end of their programmed service life and need to remain in service. The current Air

Force fleet of combat aircraft is on average older than the Navy's warship fleet.[4] As of April 2008, almost 800 aircraft were grounded or flying restricted profiles, accounting for 14 percent of the Air Force fleet.[5] Maintenance requirements have skyrocketed to include a 41 percent increase in man-hours for depot-level repairs and a 50 percent increase in operational maintenance man-hours.[6] While the Air Force struggles to maintain an aging fleet, the acquisition of future systems were cut or called into question, further exacerbating the recapitalization effort. Under Presidential Budget Decision (PBD) 720, the original Air Force acquisition of 381 F-22 Raptors was cut to only 183.[7] Based on current projections, the Air Force variant of the F-35, the Conventional Takeoff and Landing (CTOL), will not be operational until 2015. These factors combined are creating a potential "fighter gap," a term for having less aircraft in the fleet than required to support operations.[8] Additionally, USAF attempts to acquire a new aerial refueling tanker have run into significant problems which have continued to slide replacement date estimates further to the right. This is an additional aggravating factor as it has the potential to impact the availability of the aging KC-135 fleet and reduce the range and persistence of air assets in the area of operation.

While each service works through independent force structure changes and associated issues, it is clear that these changes will impact the other services. It is possible that the combination of increased requirements for fixed-wing fires by the new BCTs and looming fighter gap in the Air Force could result in a future deficit where BCT air support requirements to augment reduced artillery and armor exceeds the capability of Air Force assets. To avoid potential problems with disconnects between Army requirements and Air Force capacity, planners from both services will need to work

closely together or at a minimum work from a common set of assumptions or planning factors which this paper will attempt to define.

Primary Research Question

The primary research question this paper will focus on is if the Air Force can provide sufficient support to the BCTs engaged in a large scale conventional conflict. This question will be answered with reference to each specific type of BCT: heavy BCT (HBCT), infantry BCT (IBCT) and Stryker BCT (SBCT). The answer to the primary research question will be in the form of a planning model for each type of BCT based on the assumptions outlined later in this chapter. While it will be based on a set of assumptions, service modeling data and a hypothetical conflict baseline, it will be capable of being applied to each BCT type across the spectrum of conflict.

Secondary Research Question

The primary research question requires that two secondary research questions be answered in order to define the variables for primary question. Simply put, these two variables break down to the Army's requirement and the Air Force's capacity to support. The first variable will be defined by answering the question, how much air support does each type of BCT require when engaged in a major combat operation? The second variable will be defined by answering the question, what is the Air Force able to provide in the form of fixed-wing air support to the BCTs? The answer to this question will take into account multiple types of fighter and bomber aircraft in order to develop a common metric to measure need and capacity: fighter equivalent sorties per day.

Significance

The significance of this issue can be illustrated in the historical example of Operation Anaconda. Anaconda was an example of the Air Force and Army planning independently of one another. As a result of this disjointed planning and incorrect assumptions due to lack of communication, disaster nearly struck the operation on the first day as available fixed-wing air support on station was not integrated into the ground scheme of maneuver.[9] As the Army continues its transformation to the modular BCT and eventually to the future combat system (FCS), integration of air support will arguably become even more critical for the success of these smaller units. Even in today's counter-insurgency (COIN) environment, "BCTs have become increasingly dependent on airpower."[10] To properly integrate fixed-wing air support into BCT operations, both Air Force and Army planners must have an understanding of the other services capabilities, limitations and requirements. This paper will examine these models and assumptions each service uses and identify potential disconnects or gaps and attempt to reconcile them with an integrated planning model or where appropriate, recommendations for force structure adjustments. At the joint level, this planning model will allow planners from both services to submit a more accurate apportionment recommendation to the Joint Force Commander (JFC). This will allow requirements to be accurately quantified at the BCT level and compared to other areas of effort and missions in an effort to measure risk and shift weight of effort or force tailor ground units to offset any gaps between ground force requirements and air forces capacity.

Assumptions

For the purposes of this paper, certain controls will be established to reduce both the variables and potential resulting models. Only units, equipment and personnel organic to each type of BCT will be considered and not additional units that could potentially augment the BCT such as direct support (DS), general support (GS), and general support reinforcing (GSR) units or functional and support brigades. This includes ignoring the potential effects of support from the fires brigade or combat aviation brigade. The impact of these additional support brigades will be discussed in chapter 5 with regards to recommendations for force tailoring options in the face of air support deficits. The BCTs will be looked at as singular, self-sufficient combat units executing operations on a non-contiguous battlefield. Available Air Force capabilities are based on current projections and schedules pertaining to numbers and timelines. Future aircraft acquisitions are not included in the discussion and modeling due to the frequently changing fielding timelines and projected numbers of aircraft based on budgeting decisions. All weapons improvement programs, recapitalization and upgrades of currently fielded systems will be considered. For the purposes of the analysis portion of this paper, the Army force structure used will be the one currently projected at the completion of transformation to modular brigades as of April 2009 and the Air Force structure will use the April 2009 projections for the inventory at the end of fiscal year 2010.

Definitions

Air interdiction (AI). Air operations conducted to divert, disrupt, delay, or destroy the enemy's military potential before it can be brought to bear effectively against

friendly forces, or to otherwise achieve objectives. Air interdiction is conducted at such distance from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required. (Joint Publication (JP) 3-0)

Allocation request. A message used to provide an estimate of the total air effort, to identify any excess and joint force general support aircraft sorties, and to identify unfilled air requirements. This message is used only for preplanned missions and is transmitted on a daily basis, normally 24 hours prior to the start of the next air tasking day. Also called ALLOREQ. (JP 1-02)

Apportionment (air). The determination and assignment of the total expected effort by percentage and/or by priority that should be devoted to the various air operations for a given period of time. (JP 3-0)

Counterland. Air and space operations against enemy land force capabilities to create effects that achieve joint force commander objectives. The main objectives of counterland operations are to dominate the surface environment and prevent the opponent from doing the same. (Air Force Doctrine Document (AFDD) 1)

Close air support (CAS)**.** Air action by fixed- and rotary-wing aircraft against hostile targets that are in close proximity to friendly forces and that require detailed integration of each air mission with the fire and movement of those forces. (JP 3-0)

Fixed-wing fire support. Lethal and non-lethal effects delivered from fixed-wing platforms in the form of CAS, SCAR or AI.

Force Tailoring. The process of determining the right mix and sequence of units for a mission. (Field Manual (FM) 3-0)

Future Combat System (FCS). The U.S. Army program of record for full-spectrum-modernization comprised of a joint, networked system of systems. It is described as "14 + 1 + 1" systems which includes 14 individual systems including sensors, unmanned aerial and ground vehicles, and manned vehicles, the network (+1) and the soldier (+1). (U.S. Army white paper on FCS BCT)

Modular Force. Force structure allowing for a selective mix of units that meets the needs of combatant commanders at any time and place. (Field Manual Interim (FMI) 3-0.1)

Primary Aircraft Authorized (PAA). Aircraft authorized for performance of the unit's mission (e.g. Combat, Combat Support, Training, Test and Evaluation, etc). The PAA forms the basis for the allocation of operating resources to include manpower, support equipment, and flying hour funds. The operating command determines the PAA required to meet their assigned missions. (Air Force Instruction (AFI) 16-402)

Precision-guided munition (PGM)**.** A weapon that uses a seeker to detect electromagnetic energy reflected from a target or reference point and, through processing, provides guidance commands to a control system that guides the weapon to the target. (JP 3-03)

Strike coordination and reconnaissance (SCAR)**.** A mission flown for the purpose of detecting targets and coordinating or performing attack or reconnaissance on those targets. Strike coordination and reconnaissance missions are flown in a specific geographic area and are an element of the command and control interface to coordinate multiple flights, detect and attack targets, neutralize enemy air defenses and provide battle damage assessment. (JP 3-0)

Utilization Rate (UTE rate). The average number of sorties or hours flown per authorized or chargeable aircraft per month. Under this area, each unit is compared with their goal for the year, their monthly program goals versus their actual, and their cumulative rate so far this fiscal year. Fighter aircraft are measured with Sortie UTE Rates; all other aircraft are measured with Flying Hour UTE Rates. (AFI 10-602)

Limitations

For the purposes of this paper, specific theaters and associated operational plans or requirements will not be discussed to keep both the discussion and proposed planning models unclassified. Weapon hit rates will also be discussed in a manner to keep them unclassified. Specifics on these calculations are covered in chapter 4.

Delimitations

To limit the scope of this paper, only Air Force assets will be considered for available support to the BCT in the fixed-wing asset analysis. Navy and Marine Corps assets will not be taken into account. Army attack aviation capabilities and support as well as artillery support not organic to the BCT will also be disregarded for the purposes of this project. The potential impacts and employment of these additional assets will be discussed in chapter 5 when recommendations are made to address any situations where Air Force fixed-wing air support is unable to meet the BCT requirement. The level or type of conflict for this study will be limited to major combat operations. The reason for this is that the planning model will ultimately be used to make an apportionment recommendation. This does not apply to the lower end of the spectrum of conflict as is the case in both current theaters of operation where almost 100 percent of fighter and

attack sorties are apportioned to support the ground commander. Major combat operations (MCO) will allow for the most significant issues and potential problems to be identified while creating a model that is scalable for limited or COIN conflicts.

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[1]Elwood P. Hinman IV, "Counterair and Counterland Concepts for the 21st Century," *Joint Force Quarterly*, no. 48 (January 2008): 86.

[2]Andrew Feikert, CRS Report for Congress, *U.S. Army's Modular Redesign: Issues for Congress* (Washington, DC: Government Printing Office, 2006), 19.

[3]Ibid.

[4]Loren B. Thompson, "The Slow Death of American Airpower," *Lexingtoninstitute.org*, 16 January 2007, under "Defense," http://lexingtoninstitute.org/1040.shtml (accessed 27 September 2008).

[5]David A. Deptula, "Air and Space Power Going Forward," *Joint Force Quarterly*, no. 49 (April 2008): 83.

[6]Dave Montgomery, "An Aging Fleet has Air Force Worried," *Seattle Times*, 4 March 2007, under "Nation & World," http://seattletimes.nwsource.com/html/nationworld/2003599976_agingplanes04.html (accessed 5 September 2008).

[7]John A. Tirpak, "Affording the F-22," Washington Watch, *Air Force Magazine*, March 2006, 14-15.

[8]John T. Bennett, "USAF Joins Navy in Warning of 'Fighter Gap,'" *Defense News*, 9 April 2008, under "Americas," http://www.defensenews.com/story.php?i=3472033&c=AME&s=AIR (accessed 28 September 2008).

[9]Richard B. Andres and Jeffrey B. Hukill. "Anaconda: A Flawed Joint Targeting Process," *Joint Force Quarterly*, no. 4 (21 December 2007): 135.

[10]Hinman, 86.

CHAPTER 2

LITERATURE REVIEW

A Tale of Two Services

One might assert that the last time the USAF and U.S. Army integrated seamlessly would have been before 1947 when the USAF was not yet born and was part of the Army. Even then the differences in perspectives, planning processes and execution methodology were becoming quite clear between ground and air forces and their commanders. Despite some 60-plus years and numerous conflicts, wars and contingencies, the two services still frequently plan in a vacuum. While the services are arguably more interdependent than ever with advances in speed, mobility, information and other technologies, it has done little to bring them closer together in planning. This chapter will examine some of the most significant examples of service "stove piping." It will examine the spectrum of planning from the acquisition of major weapons systems, to force structure decisions to joint planning. In this discussion it will become apparent that the model for Army--Air Force integration, the Theater Air Control System and Army Air Ground System (TACS-AAGS), is illustrative of the overall integration between the two services: two separate systems that do not merge or integrate until the point of execution. In a RAND study on the future of Army-Air Force integration, this problem of parochial service cultures was summed up with "Close air support (CAS) will never reach its full potential if the Army and the Air Force are strangers who meet on the battlefield."[1]

Joint Doctrine

While joint doctrine by definition addresses how the services will operate together on the battlefield, it rarely covers service specific issues or even multi-service integration problems or limitations. The primary contributor to this lack of specificity in these areas is the lengthy review and re-write process of joint doctrine. For example, when Joint Publication (JP) 3-0, *Joint Operations* was released on 17 September 2006, it had been over five years since the previous release. During this period, the Air Force and Army saw drastic changes in both force structure and weapons system procurement programs (curtailments and cancellations). As a result, joint doctrine typically avoids service specific issues concerning force structure and weapons systems as is the case with this issue of the Air Force having sufficient assets to support the Army's new force structure. While joint doctrine that is applicable to this discussion does not address the primary or secondary research questions in this paper specifically, it does discuss some joint relationships and processes that will help frame the issues and assumptions involved with planning models in this area. Specifically, in JP 3-0, air apportionment is addressed (and subsequently in JP 3-09, 3-30 and 3-09.3) as an item JFCs "must pay particular attention to" because of the "many missions and tasks that joint air forces can perform."[2] Apportionment is extremely important to both the Army and Air Force because it is the first operational step or decision in determining how much fixed-wing airpower will go to supporting counterland operations in the form of air interdiction (AI) and CAS. While the Joint Force Air Component Commander (JFACC) makes the apportionment decision recommendation to the JFC, each component makes inputs to this recommendation based on objectives and operational requirements. The JFC will then make the apportionment

decision based on this recommendation along with his objectives and priorities. Planning models based on BCT types and the expected level of conflict in the theater or area of operations can provide both component planners and the JFACC's staff potentially more accurate information in making an apportionment recommendation to the JFC.

JP 3-30, *Command and Control for Air Operations*, released 5 June 2003, outlines the Joint Air Estimate Process (JAEP) which results in the Joint Air Operations Plan (JAOP). The JAOP is not just an air component product, but "details how the joint air effort will support the JFC's overall OPLAN."[3] One of objectives of the JAOP is to identify "what air capabilities and forces are required to achieve joint air objectives" which is based upon service component inputs.[4] The JAEP is the construct for determining these requirements by identifying specified and implied tasks for the air component and then "examine readiness of all available air capabilities/forces to determine if there is enough to perform all specified and implied tasks."[5] If it is determined that insufficient forces are available to fulfill these requirements, it then falls to the JFACC to "identify additional resources needed for mission success to the JFC."[6] JP 3-30 clearly defines the JAEP but fails to provide any guidance or tools for quantifying capabilities and forces to meet specified and implied tasks. As with much of joint doctrine, JP 3-30 avoids any details beyond the process itself, leaving this issue to be addressed by service doctrine or subordinate components.

Service Doctrine

While typically reviewed and published more frequently than joint doctrine, both Army and Air Force doctrine fail to address reciprocal issues that have potentially large impacts on their respective service's doctrine. In the most recent release of the Air

Force's Counterland Operations doctrine (AFDD 2-1.3), dated 11 September 2006, there is only one mention of the BCT and the Army's movement to modular units, but no discussion of the impact on air support requirements. Similarly, Army doctrine makes no mention of increased requirements for fixed-wing air support or CAS when discussing changes to force structure resulting in lighter and smaller units. There is also no discussion on potential impacts of Air Force fleet aging issues or acquisition problems. This is not surprising based on the re-write frequency of service doctrine and that fleet health issues and force structure is typically addressed in more time sensitive documents such as operational plans (OPLAN) or concepts of operation (CONOP).

Devoid of air support requirement discussion, Army doctrine is filled with the concept of quantifying force requirements. Numerical force ratio modeling is referenced throughout Army field manuals (FM) and other publications. Though force ratios are mentioned in numerous cornerstone publications such as FM 3-0 (*Operations*, February 2008), FM 5-0 (*Army Planning and Orders Production*, January 2005) and FM 34-130 (*Intelligence Preparation of the Battlefield*, July 1994), there is a great deal of disagreement and inconsistency on how force ratios should be applied. The lack of consideration for non-organic joint fires in calculating these force ratios is the one area where these FMs are consistent.

The recent history of Army force ratio modeling can be tied to planning for conventional warfare against the Soviet Union on the plains of Europe. The operational problem the North Atlantic Treaty Organization (NATO) faced at the time was that the enemy had far superior numbers, but different weapons systems. Force ratios attempted to go beyond the basic numbers of units and equipment, but quantify different types of

systems from a baseline that was grounded in different criteria such as mobility, firepower, and protection.

The basis for numerical force ratio modeling is captured in a number of current and outdated Army FMs. While much of the discussion of using a scientific approach has evaporated from Army doctrine, replaced by more dialogue on the art of command along with mission, enemy, terrain and weather, troops available, time available and civil considerations (METT-TC), the remnants still remain in keystone FMs such as FM 5-0 and FM 34-130. FM 3-0, updated in February 2008 highlights the desire to eliminate numerical or scientific approaches to evaluating the projected capability of one force over another, referenced in the manual as "combat power."[7] In the chapter dedicated to this topic, FM 3-0 clearly states that "combat power is not a numerical value" and that it "can be estimated but not quantified."[8] It goes further by saying "combat power is always relative" and is simply "unrealized potential."[9] While it is an arguably valid assertion that there are intangibles that factor into determining the combat power of a unit, it appears FM 3-0 asserts there is no longer a place to take numerical values into account when weighing the capability of one unit against an enemy. In contrast, FM 5-0 talks very specifically about the roles that force ratios and numerical analysis play in planning operations. It states the analysis of combat power "requires applying both military art and science" and "includes determining force ratios."[10] In contrast to FM 3-0, FM 5-0 acknowledges the need to consider numerical comparisons in addition to non-tangible factors. While it does not present it as a black and white standard, FM 5-0 provides historical minimum planning ratios, shown below in figure 1, as a guide "to determine what types of operations are feasible."[11]

Friendly Mission	*Position*	*Friendly: Enemy*
Delay		1: 6
Defend	Prepared or fortified	1: 3
Defend	Hasty	1: 2.5
Attack	Prepared or fortified	3: 1
Attack	Hasty	2.5: 1
Counterattack	Flank	1: 1

Figure 1. Historic Planning Force Ratios
Source: Headquarters, Department of the Army, Field Manual (FM) 5-0, *Army Planning and Orders Production* (Washington, DC: Government Printing Office, 2005), 3-32.

FM 34-130 is on the opposite end of the spectrum from FM 3-0, recommending a purely scientific approach to evaluating combat power, even warning against "the temptation to attempt to account for other, less tangible factors such as leadership and flexibility."[12] Of note is that FM 34-130 has not been updated since 1994, while FM 3-0 is current as of 2008, reflecting the shift in focus away from mathematical models in more recent doctrine. FM 34-130 gives some basic guidance for computing force ratios, to include taking into account different force structures and associated equipment (number of tanks in a U.S. battalion versus an enemy battalion) as well as the relative "combat capability" or "combat power" between similar weapons systems.[13] The guidance becomes very arbitrary at this point as it allows the planner or user to assign comparative values based on their personal assessment instead of providing any scientific baseline. The example given for this determination of comparative capability is simply stated as "we may decide that an M1 tank has twice the combat power of a T-55 tank"

without providing a basis for the evaluation such as superior firepower, mobility or protection.[14] This has the potential to lead to biased assessments of combat potential or comparisons in an effort to influence overall calculations and ratios.

To find a more scientific and mathematical basis for calculating force ratios, FM 100-61, *Armor- and Mechanized-Based Opposing Force Operational Art* and the Battle Command Training Program (BCTP) Opposing Force (OPFOR) Command and Staff Handbook provides the baseline for the planner. The BCTP OPFOR handbook is based on Soviet mathematical modeling techniques and procedures that were expected to be employed not only in planning for combat, but as a decision-making tool while executing or leading in combat.[15] While the mathematical equations and graphical plots are in-depth and very extensive in this handbook, there is still a great deal of judgment involved on the part of the individual conducting the analysis. Similar to the pitfalls discussed with assigning comparative values in the procedures outlined in FM 34-130, the BCTP OPFOR handbook allows for individual assessment of commensurability between various weapons systems. The handbook does warn the reader the practice of scoring various classes of dissimilar weapons systems against one another involves "a lot of judgment."[16] Though steeped in mathematical analysis, the Soviet style of modeling presented is still very dependent on individual judgment and therefore prone to an individual's biases and heuristics. This is not to say that the modeling techniques presented are invalid or flawed. As long as variables left to individual judgment are applied consistently to the model and grounded in some basis of fact and logic, the overall integrity and validity of the model should remain intact.

A simplified example will better illustrate the application of this concept. If a planner compares two tanks, he first attempts to isolate the differences. If the protection or survivability and mobility of the two tanks is equal, but the size and range of their main guns are different, then a value is assigned to show either the superiority or inferiority of one compared to the other. If a value of 1.0 is assigned to tank A and tank B has a main gun with a 20 percent greater range, then tank B might be assigned a value of 1.2. This comparative value would be applied in the same way between other types of weapons, such as artillery or aircraft. The difficulty in this value assignment system is comparing dissimilar weapons such as tank A to artillery cannon B. In this case, a baseline is set for a particular variable such as protection, firepower or mobility. Going back to the first example, tank A may have been the baseline with its 100mm gun and all other systems were measured in relation to it, leading to the conclusion tank B was equipped with a 120mm gun if the variable being measured is firepower and the unit of measure or comparison is gun size.

FM 100-61 takes the correlation of forces and breaks it down from mathematical equations to a more simplified and usable product for commanders and planners when examining the numerical part of mission analysis. While the manual does not provide specific values for individual weapons systems or units, it provides the methodology to do a correlation of forces calculation. The basic methodology builds on the BCTP template of using a comparative analysis between like-type weapons systems. In the FM 100-61 OPFOR model, an "arbitrarily adopted standard unit of armament" is used as a baseline from which all other systems are measured from.[17] This method of comparison allows for dissimilar types of weapons systems to be compared, resulting in "aggregate

combat potential values."[18] Instead of comparing forces tank for tank or artillery cannon for artillery cannon, this model provides commanders and planners the methodology for evaluating combined arms units. As a result, the model not only accounts for advantages of superior equipment and systems in the face of inferior numbers, but also allows deficiencies in certain weapon systems types to be identified and subsequently balanced with other available systems of different type but similar combat potential value. This model has increased utility over others because it allows for unit planners and commanders to quantify potential force augmentation requirements in the face of insufficient force ratios, including weapon systems not organic to their organization. For example, if a combined arms battalion (CAB) commander found himself with insufficient tanks to meet the desired force ratio to execute a prepared attack, he could identify additional forces not within the battalion that would allow him to meet his desired ratio, such as a battery of 155mm howitzers or a company of AH-64 attack helicopters. This capability is particularly useful under the current modular construct of the Army where modifications to task organization are easily executed and part of the doctrine. The ability to not only identify the requirement for additional augmenting or supporting capabilities, but to quantify them is extremely useful for planning as well as generating force and support requirements. Instead of simply requesting supporting artillery or attack aviation assets, planners and commanders can specify exact amounts or unit sizes to fulfill their requirement without "wasting" assets by requesting excessive amounts of support due to an inability to quantify and justify their need based on anything other than 'gut feel'. This allows for a more efficient distribution and use of supporting assets, especially when in great demand during an MCO-type conflict. This style of modeling

also allows higher echelon planners the ability to more efficiently task organize and leverage the modularity construct by quantifying the impacts of moving units out of one organization and into another without causing significant imbalances in combat power across the board. This concept will be the foundation for the proposed integrated model discussed in detail in chapter 4.

White Papers

Despite very parochial approaches to this problem in service doctrine, a number of white papers from both Air Force and Army officers have identified problems involved with individual services conducting planning independent and parallel to one another. Recognizing the potential issues involved with this stovepipe-style planning, most of these papers fall short of providing any sort of integrated or combined planning model that attempts to quantify requirements and capabilities of both services. The focus of white paper topics and discussions follow closely with Army doctrine; earlier papers focus on force ratio models while later papers address the impacts of transformation and modularity and the need to augment capability shortfalls with air support.

In his December 1991 School of Advanced Military Studies (SAMS) monograph, Army Major A. Dwight Raymond offers a model for estimating ground force combat power. He points out in his paper that such modeling is “not a new phenomenon,” but attempts to provide an updated methodology.[19] At the conclusion of his monograph, Major Raymond notes that air forces are not included in the model and recommends that combat potential scores (CPS) be determined for fixed-wing aircraft in future studies.[20] Army Major David Hogg continued the dialogue on the need for models to calculate force ratios in his February 1993 SAMS monograph. In this he recommends that a

"standardize(d) methodology in computing COF (correlation of forces) that is realistic, usable and based on quantifiable values" be established.[21] Army Major Brian Barham's May 1995 SAMS monograph discusses the merits of determining a relative combat power value. His paper builds on and refines previously proposed and discussed models for calculating force ratios, but falls short in incorporating fixed-wing air support. He does take note of enemy CAS capability in one example, but fails to quantify it with the rest of enemy forces and capabilities.[22] CAS requirements are also highlighted as a key component of friendly firepower for course of action development, but again not quantified with the other elements of combat power.[23] In his conclusion, Major Barham notes two significant shortfalls in the doctrinal use of force ratios for combat power analysis. He points out that Army planning doctrine recommends conducting "a relative combat power analysis without relating how that analysis should be accomplished," and that most techniques do "not account for all the elements of combat power."[24]

The topic of using force ratios for combat power analysis rapidly falls off after the late 1990s, following a similar trend in Army doctrine. Shortly thereafter, this void is filled with the discussion on the impacts of Army transformation. In his 2002 SAMS monograph, Army Major Bryan Luke asks the question "will close air support be where needed and when to support objective force operations in 2015?"[25] In his research, he notes that the transformed force will "be lighter and more vulnerable to direct fire" and therefore a "higher value will be placed on CAS (than in current Army doctrine)."[26] The disconnect between Army and Air Force doctrine highlighted by Army transformation is not limited to Army doctrine. Air Force Lt Col John Berry addresses similar requirements for increased support to the Army in his February 2005 Air War College

research report. He predicts that "the Army plans to use airpower integration to replace the void in organic fires capability."[27] He points out this will impact the Air Force as "increased demand for air support brings significant manpower and resource requirements."[28] In his March 2006 Army War College research project, Air Force Lt Col James Reed examines some of the impacts of increased Army demand for air support. He also points out the modular BCTs will "have less organic fire support directly available thus making them more reliant on other sources for fire support such as Army attack aviation and Air Force CAS."[29] He then goes beyond Berry's assessment of the impact on the Air Force, arguing that there is a "disconnect between current Air Force capabilities and future Army requirements."[30] Both Berry and Reed focus their research on the impacts of Army transformation and modularity on Air Force terminal attack control for CAS capabilities, specifically Joint Terminal Attack Control (JTAC) and Air Support Operations Center (ASOC) manning and alignment. While white papers from both services agree on the increased requirement for air support, none address potential impacts of Air Force transformation and modernization or attempt to quantify the Army's requirement or Air Force's capability deficit in terms of aircraft or sorties.

Studies/Briefs

The RAND Corporation, Government Accountability Office (GAO) and Congressional Research Service (CRS) have produced a number of studies and reports that shed the most light on the potential problem surrounding the primary research question in this paper. Specifically, this is the first level at which service interdependence issues are discussed or highlighted. In some cases, such as the RAND report on CAS, they underscore the services' reluctance to recognize the impacts of

changes by one service on another, stating "Impassioned advocates of air power typically do not speak or write a great deal about counterland air attack."[31] The study goes further to define the impacts of Army Transformation on the Air Force stating that it will "complicate Air Force counterland operations."[32] While there are not concrete numbers or projected requirements created by the Army's move to smaller, more agile BCTs, the study does attempt to highlight a potential requirement in terms of "Future Army forces will rely more on air power to help them survive and to apply lethal firepower," and "air power might be a crucial source of additional lethality."[33] The study appears to assert that the Army is ignoring the requirement for more air support while the Air Force ignores the need to support that requirement or is simply ignorant that the requirement exists in the first place.

Periodicals

Most periodicals follow similar trends discussed above, falling along service lines, addressing service-specific issues and impacts and failing to address interoperability and integration impacts between services. For example, numerous articles focus on how transformation to modular BCTs and the associated reduction in field artillery units and equipment is impacting the field artillery branch of the Army. Much of the discussion is centered on making field artillery more accurate through the use of precision-guided munitions (PGM) and inertially-aided munitions (IAM), such as the Excalibur round and guided multiple launch rocket system (GMLRS) projectile. Most of these articles are limited to military periodicals such as Military Review and Field Artillery magazines.

Discussion of Air Force modernization issues has received a great deal of attention in recent periodicals, mainly due to highly publicized aircraft fleet groundings due to fatigue issues. While the grounding of the F-15C fleet in late 2007 gained some attention, the impact to the other services was negligible because the aircraft were not directly supporting their ongoing combat operations in Iraq and Afghanistan. The case was not the same when half of the A-10 fleet was grounded in late 2008. The loss of A-10s on the battlefield directly impacted combat operations in Afghanistan where A-10s provide a large portion of the Army and coalition forces' CAS. In the April 2008 Joint Force Quarterly, Air Force Lt Gen David Deptula noted that at the time, 800 aircraft, 14 percent of the Air Force fleet were either grounded or flying under restrictions.[34] In the same article, defense analyst Loren Thompson indicated that "the Air Force that prevented any American soldier from being killed by enemy aircraft for half a century may not be up to the task in the years ahead due to lack of adequate investment."[35] The Air Force's aging fleet has received increased attention as of late because of budget issues and battles over funding for new aircraft systems like the F-22 Raptor and F-35 Joint Strike Fighter. In November 2008, the Air Force announced it would retire over 300 fighter aircraft to pay for more airmen and ISR platforms, including 177 F-16s and 9 A-10s.[36] While both of these aircraft are actively supporting the Army in both Iraq and Afghanistan, no mention was made of the impact this budgeting decision would have on the Army in particular or the Air Force's capability to provide CAS. In a recent article in the Air Force Times, the impending retirement of the Air National Guard (ANG) F-16 fleet starting in 2011 without a replacement plan is discussed.[37] While the article initially focuses on the impact on the ANG's traditional mission of homeland defense, it does

point out that it also impacts the mission in Iraq where the Guard is responsible for 31 percent of the combined Air Force fighter mission and flew over 40 percent of the F-16 sorties over Iraq in the last quarter of 2008.[38] The recent announcement of Department of Defense budget cuts by Secretary Gates will likely bring more attention to this issue as he announced the cancellation of any further purchase of F-22s, the early retirement of 250 fighter and attack aircraft and significant cuts for the Army FCS program.[39]

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[1]Bruce R. Pirnie, Alan Vick, Adam Grissom, Karl P. Mueller, and David T. Orletsky, "Beyond Close Air Support: Forging a New Air-Ground Partnership," *RAND Corporation Project Air Force Study for the United States Air Force* (2005): 113.

[2]U.S. Department of Defense, Joint Publication (JP) 3-0, *Joint Operations* (Washington, DC: Government Printing Office, 2008), III-19.

[3]U.S. Department of Defense, Joint Publication (JP) 3-30, *Command and Control for Air Operations* (Washington, DC: Government Printing Office, 2003), III-14.

[4]Ibid., III-15.

[5]Ibid., III-5.

[6]Ibid.

[7]Headquarters, Department of the Army Field Manual (FM) 3-0, *Operations* (February 2008): 4-1.

[8]Ibid., 4-2.

[9]Ibid.

[10]U.S. Army Field Manual (FM) 5-0, *Army Planning and Orders Production* (January 2005): 3-30.

[11]Ibid., 3-32

[12]U.S. Army Field Manual (FM) 34-130, *Intelligence Preparation of the Battlefield* (July 1994): B-38.

[13]Ibid.

[14]Ibid.

[15]U.S. Army Battle Command Training Program (BCTP) Opposing Force (OPFOR) Command and Staff Handbook (July 1990): 5-52.

[16]Ibid., 5-83.

[17]U.S. Army Field Manual (FM) 100-61, *Armor- and Mechanized-Based Opposing Force Operational Art* (January 1998), chapter 7, http://www.globalsecurity.org/military/library/policy/army/fm/100-61/Ch7.htm#s8 (accessed 10 December 2008).

[18]Ibid.

[19]Allen D. Raymond, "Assessing Combat Power: A Methodology for Tactical Battle Staffs" (Monograph, School of Advanced Military Studies, 1992), 5.

[20]Ibid., 29.

[21]David R. Hogg, "Correlation of Forces: The Quest for a Standardized Model" (Monograph, School of Advanced Military Studies, 1993), 40.

[22]Brian D. Barham, "What is Relative About Combat Power?" (Monograph, School of Advanced Military Studies, 1995), 32.

[23]Ibid., 36.

[24]Ibid., 46.

[25]Bryan K. Luke, "Will Close Air Support be Where Needed and When to Support Objective Force Operations in 2015?" (Monograph, School of Advanced Military Studies, 2002), 68.

[26]Ibid.

[27]John C. Berry, "Army Echelon Redesign--Ramifications for the U.S. Air Force" (Research report, Air War College, 2005), 30.

[28]Ibid.

[29]James D. Reed, "Army Transformation's Impact on Close Air Support Terminal Attack Control" (Strategy Research Project, U.S. Army War College, 2006), 3.

[30]Ibid.

[31]Pirnie et al., "Beyond Close Air Support," 21.

[32]Ibid., 111.

[33]Ibid., 112.

[34]David A. Deptula, "Air and Space Power Going Forward" *Joint Force Quarterly*, no. 49 (April 2008): 83.

[35]Ibid.

[36]Sam LaGrone, "Trade-off," *Air Force Times,* 3 November 2008.

[37]Sam LaGrone, "Air Guard Losing its Fighter's Punch," *Air Force Times*, 30 March 2009.

[38]Ibid.

[39]Elisabeth Bumiller and Christopher Drew, "Gate's Cuts to an Array of Weapons to Bring a Fight," *New York Times,* 8 April 2009.

CHAPTER 3

RESEARCH DESIGN

While a great deal of information exists on Army transformation and Air Force modernization issues, there is limited data available on how each impacts the other. To answer the primary research question proposed in chapter 1, a construct was required that would allow the two services' issues to be compared in a common context. The literature detailed in chapter 2 highlighted the absence of such a construct.

Research Criteria

Initial research was conducted to determine the existence of and respective history behind force ratio models for both the Army and the Air Force. The Army had a vast and varied history of force ratio use in determining relative combat power and numerous unofficial force ratio calculation methods in use. Two existing Army force ratio calculation models were found in use and one was selected for use in this paper based on the validity and applicability of the model to answer the primary research question. While the other model was found to be perfectly valid, it was less suited for use in the analysis of air support requirements. The selected Army model for analysis was then used as the baseline for developing a proposed integrated model that included fixed-wing air support assets. The Air Force was found to have no accepted standard model or methodology for determining air support requirements to the Army beyond what is outlined in JP 3-30 and discussed in chapter 2.

Once a proposed integrated model was determined, a second construct was required to put the model to use in an effort to answer both the primary and secondary

research questions posed in chapter 1. To do this, a modified case study was used involving a specific battle in Operation Desert Storm. Desert Storm was chosen over more recent conflicts because the focus for this research is on MCO and this was the last time the Army was involved in a large-scale force on force battle involving multiple divisions. The battle chosen for use in the case study was the VII Corps attack on the Iraqi Republican Guard Tawakalna Division. This battle was selected not only on the basis that it is regarded as the decisive battle of the Desert Storm ground campaign, but that it also involved a well-equipped enemy force and friendly force ratios that were not overwhelming.[1] The forces involved in this battle were also easily substituted by the current forces of BCTs and a modernly equipped peer competitor to accurately depict a potential modern MCO battle for analysis of the primary research question.

Research Methodology

The analysis in this paper will consist of four basic parts: existing force requirement planning models used by the Army and Air Force; a proposed integrated force ratio model; impacts of transformation and modernization on both services; and finally a modified case study that will answer the primary research question.

The first section of chapter 4 will focus on the histories and use of planning models by the Army and the Air Force. The history of the models will be examined to determine the doctrinal basis for them and identify updates and modifications to them as the service has updated equipment, force structure and doctrine. Similarities and differences between the services' models will also be discussed in an effort to determine a best model or specific assumptions or inputs from each that can be combined into an optimized planning model.

The second section will build on the data obtained in the previous section in an effort to produce an integrated planning model that will be the basis for the remainder of the analysis. The critical requirement to achieve a valid model will be the determination of a common unit of measure between the services. The integrated model will be used to answer the secondary research question of how much air support a BCT requires.

The next section will then put the integrated model to use in evaluating both Air Force and Army force structure changes as a result of transformation and modernization. To do this, integrated model examples will be used to compare legacy brigades' combat power to that of the different types of BCTs. These differences will then be quantified in terms of required Air Force support. Changes in the overall force structure of each service will then be compared to identify any significant difference in overall capability and corresponding change in requirement for support by the Army or ability to provide support by the Air Force.

Finally, a modified case study using a battle from Desert Storm will provide the context to answer the primary research question. The case study will examine three different variations on the same battle. The first will be a historical analysis of force ratios between VII Corps forces and the Iraqi Republican Guard Tawakalna Division just prior to engaging in battle. The second comparison will involve replacing legacy VII Corps brigades with BCTs and the Iraqi force with a peer competitor-equipped force. This example will include the same starting combat power degradation the Iraqi force experienced as a result of a preceding air campaign. The last variation will involve the same forces as the second comparison, but will not degrade the enemy starting combat power at all, simulating a simultaneous air and ground campaign start.

Chapter 5 will take the results of the modified case study and put them into the larger context of the projected result of Army and Air Force transformation and modernization. Recommendations will be made if and where required to mitigate or accept risk as well as offer alternative solutions to bridge or fill any identified gaps between requirements of the Army and capabilities of the Air Force. Other methods to include force structure adjustments or strategic and operational planning considerations for the sequence or timing of phases leading to and the execution of a major combat operation will also be discussed. Finally, areas for further and future research will be proposed based on the results of the research and analysis in this paper as well as conclusions.

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[1]Richard M. Swain, *Lucky War: Third Army in Desert Storm* (Fort Leavenworth, KS: U.S. Army Command and General Staff College Press, 1994), 246.

CHAPTER 4

ANALYSIS

Correlation of Forces

As discussed in chapter 2, Army doctrine is disjointed and inconsistent on the proper balance between mathematical computations and intangible factors when evaluating force ratios. Despite significant disagreement on the optimum mix of science and art in force ratio modeling, Army doctrine is consistent in its guidance that numerical comparisons are still useful in assessing relative combat power. Air Force doctrine is devoid of any discussion on force ratios or correlation of forces. Mathematical models are still actively used in simulations, to include those used at the Army Command and General Staff College (CGSC) and by BCTP. These models will serve as the basis for generating an integrated model to determine a correlation of forces using both ground and air combat power. Before arriving at an integrated model, a service-specific model from both the Army and Air Force were selected. With multiple models already in use, the existing Army models were examined to determine which had the greatest utility as part of an integrated model. As mentioned above, the Air Force has no mathematical models currently in use for this application, so one was created for incorporation in the integrated model.

Army Model

There are currently at least two different Army models circulating in the operational, academic and testing communities. While both models follow the same methodology of a force correlation based on weighted values that represent combat

potential, they use different scales and weights. The older of the two models was last published in CGSC Student Text 100-3 in July 1999 and is referenced as the CGSC model throughout this paper. The other model is currently employed by BCTP, updated in 2002 and is referenced as the BCTP model. The CGSC model is based on battalions or battalion-sized equivalents and is limited to major weapon systems such as tanks, IFVs, artillery and helicopters. The CGSC model includes both friendly and enemy systems and also accounts for BCT CABs. While the BCTP model includes both friendly and enemy systems and also allows for calculations involving BCT CABs, it is based on single weapons systems, including individual soldiers. The BCTP model also takes into account air defense systems whereas the CGSC model does not. One of the most significant differences, however, is the weight differences between individual weapons systems. Table 1 shows the different weights assigned by both models.

Table 1. Army Model Comparison

UNIT TYPE	BCTP VALUE	CGSC VALUE
CAB	35550	1.79
Legacy Armor BN	42900	1.30
Stryker BN	10600	0.93
AH-64 BN	26400	5.00

Source: U.S. Army Command and General Staff College (CGSC), Student Text (ST) 100-3, *Battle Book* (Fort Leavenworth: U.S. Army CGSC, 1999); U.S. Army Battle Command Training Program (BCTP), Spreadsheet: “Correlation of Forces and Means,” February 2002.

While the numbers alone do not reflect the significant differences in like unit weights, the ratios between different types of units highlights the difference in models as calculated in table 2.

Table 2. Army Model Ratio Comparison

Unit Comparison	BCTP Model	CGSC Model
CAB vs Legacy Armor BN	1:1.21	1.38:1
CAB vs Stryker BN	3.35:1	1.92:1
CAB vs AH-64 BN	1.35:1	1:2.79

Source: U.S. Army Command and General Staff College (CGSC), Student Text (ST) 100-3, *Battle Book* (Fort Leavenworth: U.S. Army CGSC, 1999); U.S. Army Battle Command Training Program (BCTP), Spreadsheet: "Correlation of Forces and Means," February 2002.

Of note when comparing the two models, there are not only large differences in the ratios, but the direction of those ratios varies greatly. For example, the BCTP model shows the CAB having almost three and a half times the firepower advantage over a Stryker battalion whereas the CGSC model shows the advantage to be closer to two to one. Similarly, the BCTP model shows an AH-64 battalion at a deficit when compared to a CAB while the CGSC model shows the same AH-64 battalion at nearly a three to one advantage over the CAB. The CGSC model is used as the baseline model in this paper because it is a unit-based approach versus equipment-based.

Air Force Model

The Air Force currently lacks a standardized model that is accepted as the baseline for determining the amount of "air" required to directly support the Army or an individual Army unit. The likely reason for this are the numerous variables involved in projecting the likely effectiveness of air sorties flown in support of the land component. Accuracy of aircraft targeting systems, types of weapons and their associated accuracy, target types, terrain, threats and weather are all variables that can individually impact a sortie's effectiveness and therefore complicate planning and prevent the establishment of a baseline grounded in equivalent values.

For the purposes of this research paper, a few key specific inputs will be used to determine a force coefficient for each type of combat air force (CAF) platform that might be tasked to directly support the BCT with CAS, strike coordination and reconnaissance (SCAR) or kill box interdiction (KI). To keep the model consistent, inputs were selected that were common across all airframes. Two steps were taken to arrive at a coefficient of force. First, an individual firepower rating was derived for each aircraft (A/C) by taking the number of weapons each aircraft would expect to carry as part of a CAS standard conventional load (SCL) and then applying a historic hit rate (probability of hit or P_h) for that aircraft:

$$\text{A/C Firepower Rating} = \text{SCL} \times P_h$$

The standard weapon considered for the CAS SCL in the model was a 500-pound class of PGMs and IAMs. This weapon class included the guided-bomb unit (GBU)-12 laser-guided bomb (LGB), GBU-38 joint direct attack munition (JDAM), GBU-54 Laser

JDAM and air-to-ground missile (AGM)-65 Maverick missile. While additional weapons carried by fighter aircraft such as 2.75” rockets and 20 millimeter (mm) or 30mm cannons are typically employed in CAS missions, they were not considered as they are not common to all CAF platforms considered and their effectiveness is far more difficult to assess and compare quantitatively from an effectiveness standpoint. The 2000 pound class of PGMs and IAMs were not considered as they are typically not employed in close proximity to friendly troops. Cluster munitions such as cluster bomb unit (CBU)-103/105 were also disregarded based on a limited capability to quantify their hit rates. By only considering 500 pound class PGMs and IAMs, the firepower ratings are relatively conservative, particularly for fighter platforms where guns and rocket systems add additional combat power. Probabilities of hit were determined for each aircraft by averaging the historic hit rate for each type of PGM and IAM they were capable of delivering. For the fighter platforms, this was the average of the AGM-65, GBU-12 and GBU-38. For bombers it included the GBU-12 and GBU-38. Each aircraft was also assumed to be carrying an advanced targeting pod (ATP) and therefore able to self-generate target coordinates for IAMs or self-designate for laser-guided weapons. This assumption allowed each platform to operate as an independent kill chain, not requiring any additional support for target detection, tracking or targeting. The results of these calculations are shown in table 4 below.

Table 3. Aircraft Firepower Ratings

Aircraft	# PGMs	Hit Rate	A/C Firepower Rating
A-10C	6	0.62	3.72
F-15E	8	0.64	5.12
F-16C	4	0.63	2.52
B-1B	15	0.95	14.25
B-52H	22	0.83	18.26

Source: James A. Barnes, 86th Fighter Weapons Squadron, Air-to-Ground Weapon System Evaluation Program, Interview by author, 3 April 2009.

The next step in determining the Air Force (AF) force equivalent considers the number of deployable aircraft and sorties those units could generate based on the number of aircraft available and associated maintenance metrics, referred to as utilization (UTE) rate. These factors allow for a determination of how many sorties a unit could reasonably be expected to produce in a given 24 hour air tasking order (ATO) cycle based on historical data. UTE rate is then multiplied by the firepower rating for the specific aircraft to produce a force equivalent value for each specific unit type:

AF Force Equivalent = (A/C assigned) x (UTE rate) x (A/C Firepower Rating)

Fighter UTE rates were taken from historical data obtained during Operation Desert Storm. These rates were chosen over 10-year historical averages because the 10-year rates are predominantly based on non-contingency flying which only cover eight to twelve hour daily flying periods compared to 24 hour operations during combat. UTE rates were used over basic sortie generation rates to account for maintenance effectiveness impacts. Aircraft assigned inputs were based on standard primary aircraft

authorized (PAA) under the current force structure and assumes the entire squadron is deployed. The result of this calculation is an assigned value that represents the potential firepower employed by a given CAF unit in a 24 hour period and is labeled AF Force Equivalents in table 4. Because the calculation is weapon based and takes into account P_h, it represents the approximate total number of desired mean points of impact (DMPI) that a unit could target and hit in that period. Force equivalent values for each unit type are shown below in table 4:

Table 4. AF Force Equivalents

A/C Type	# A/C per unit	UTE rate	Firepower Rate	AF Force Equivalent
A-10C	18	1.45	3.72	97.09
A-10C	24	1.45	3.72	129.46
F-15E	18	1.07	5.12	98.61
F-15E	24	1.07	5.12	131.48
F-16C	18	1.22	2.52	55.34
F-16C	24	1.22	2.52	73.79
B-1B	8	0.6	14.25	68.40
B-52H	8	0.6	18.26	87.65

Source: James A. Winnefeld, Dana J. Johnson and Preston Niblack, *A League of Airmen: U.S. Air Power in the Gulf War* (Santa Monica: RAND, 1994), 246.

The Integrated Model

Converting the Air Force model outputs to values compatible with the Army force ratio calculator is difficult due to numerous factors. First, the values in the Army model are comparative and derived from a baseline, not stand alone computations based on an individual system's capabilities. Additionally, the Air Force model is based on firepower

potential alone and does not consider maneuver or survivability factors. Aligning the models requires some of these variables not shared between the two to either be eliminated or adjudicated. While elimination of variables would be the easiest method, it would require ignoring maneuverability and survivability values for ground combat weapons systems. This would arguably render the model impractical and unrealistic, valuable only for a narrow spectrum of academic discussions and analysis.

To allow a direct comparison, the Army model was kept intact and a method of resolving the maneuver and survivability issue with Air Force platforms was examined. Based on earlier delimitations outlined in chapter 1, the survivability factor is not an issue because the threat to air operations is considered minimal based on a level of air superiority that includes the degradation of enemy air defense systems. Furthermore, the weapons considered in the analysis are all capable of being employed outside of the envelope of small arms, small and medium caliber anti-aircraft artillery (AAA), and man-portable air defense systems (MANPADS). Based on the medium in which aircraft operate and the assumption of air superiority, maneuverability is also removed as an impacting variable. However, the potential impact of employment in a less permissive environment due to air-to-air and surface-to-air threats will be discussed in chapter 5. By eliminating the factors of maneuverability and survivability from the equation, the only remaining problem was to determine a coefficient to convert values from the Air Force model to those used in the Army model.

The challenge of combining the two existing models is determining a common denominator that allows for the conversion of a system force correlation value from one model to the other. To do this, the AH-64 was the logical choice as it already existed in

the Army model, but could be converted to the Air Force model based on the methodology described for Air Force assets. While fixed-wing fighter and bomber aircraft cannot be easily converted using firepower, maneuver and protection standards used by Army maneuver systems, the AH-64 carries PGMs in the form of the AGM-114 Hellfire and have the same sortie and maintenance inputs used in the Air Force model. To determine a conversion factor between models, the AH-64 is inserted in the Air Force model using an SCL of eight PGMs. Though capable of carrying up to 16 AGM-114s, the same methodology used to determine Air Force aircraft SCLs was applied to the AH-64. In the case of the AH-64, the SCL selected was the one most likely employed in a close combat attack (CCA) mission. This equated to eight PGMs based on a configuration of two rocket pods and Hellfire missiles. As with the fixed-wing fighters, the capabilities of the 30mm cannon and rockets are not considered, though significant components of the AH-64's firepower capability. Once the AH-64 inputs were calculated in the Air Force model, the resulting coefficient was used to generate a conversion factor to change fixed-wing platforms to Army model force coefficients in table 6.

Table 5. AH-64 conversion

Aircraft	# PGMs	Hit Rate	A/C Firepower Rating
A-10C	6	0.62	3.72
F-15E	8	0.64	5.12
F-16C	4	0.63	2.52
B-1B	15	0.95	14.25
B-52H	22	0.83	18.26
AH-64D	8	0.79	6.32

Source: U.S. General Accounting Office, Operation Desert Shield/Desert Storm: Observations on the Performance of the Army's Hellfire Missile, 2; James A. Barnes, 86th Fighter Weapons Squadron, Air-to-Ground Weapon System Evaluation Program, Interview by author, 3 April 2009.

The conversion factor allows the previously computed values from the Air Force model to be changed from AF force equivalents to Army force equivalents. The utility of this conversion is two-fold. First, this allows for an assessment of the additional force and firepower provided by allocated CAS sorties distributed to the BCT. Force ratios are typically calculated without consideration for dedicated CAS sorties. Instead of being treated as an insurance policy or firepower in addition to sufficient force ratios for selected courses of action, the same CAS sorties can be used as a determining factor in meeting required force ratios for a planned action. The other purpose this conversion serves is the larger issue of examining the capability of fighter and bomber units to augment or replace reduced amounts of ground forces, equipment and capabilities. While this model does not account for intangibles such as training, leadership or morale, and assumes away variables such as weather and terrain, it does provide another planning tool to staffs and commanders at all levels to conduct more accurate force-tailoring by

integrating fixed-wing air support into the analysis. The conversion factor and subsequent fixed-wing Army force equivalent ratings are shown below in table 6.

Table 6. Air Force Units Converted

A/C Type	# A/C per unit	UTE rate	Firepower Rate	AF Force Equivalent	Army Model Conv
A-10C	18	1.45	3.72	97.09	3.20
A-10C	24	1.45	3.72	129.46	4.27
F-15E	18	1.07	5.12	98.61	3.25
F-15E	24	1.07	5.12	131.48	4.33
F-16C	18	1.22	2.52	55.34	1.82
F-16C	24	1.22	2.52	73.79	2.43
B-1B	8	0.6	14.25	68.40	2.25
B-52H	8	0.6	18.26	87.65	2.89
B-52H	12	0.6	18.26	131.47	4.33
AH-64D	24	1.0	6.32	151.68	5.00
			Conversion factor	0.033	

Source: Regina G. Burns, Concepts and Requirements Directorate, U.S. Army Aviation Center for Excellence, Interview by author, 2 April 2009; James A. Winnefeld, Dana J. Johnson, and Preston Niblack, *A League of Airmen: U.S. Air Power in the Gulf War* (Santa Monica: RAND, 1994), 246.

The conversion factor allows for any platform to be converted from the Air Force model firepower rating to the Army model force equivalent. The utility is that the inputs from the Air Force model are easily modified so any size of deployment package can be input and subsequently converted. It also allows for force ratio computations using sorties from one unit or across different units and platforms. Though arguable that there is limited application for determining the force equivalent for an entire Air Force fighter or bomber squadron at the tactical planning level, it serves a very useful purpose at the operational level for planning, force tailoring or determining appropriate deployment

packages. At the strategic level and for the purposes of this paper, it can be used to examine service force structure.

Modular Force--Legacy Force Comparison

As discussed in chapter 1, the Army has accepted reductions of artillery and armor in an effort to become lighter and more agile. While this goal has possibly been met with the new modular BCT construct, there is a cost in the form of reduced firepower and protection. This cost was expected to be offset by a number of capabilities, including increased speed and maneuver, information superiority and airpower. Previously, the effect of information superiority and airpower was relatively immeasurable and as a result not considered or contested.

Reduction figures in organic artillery and armor within the brigade are wide ranging based on the source and assumptions. Instead of attempting to choose which figures to use or accepting any of them at face value, this paper will examine these differentials in terms of force equivalents using the joint model by comparing current BCTs with similar legacy brigades. While there is no way to compare truly equivalent units in the sense of force structure and equipment, the intent is to show the cumulative impact of modularity. The combat power comparisons are limited to the major weapons systems and supporting artillery. The first comparison is between the heavy BCT and the legacy armor brigade:

Table 7. HBCT--Armor Brigade Comparison

Force Ratios										
Friendly Forces (HBCT)						Friendly Forces (Legacy Armor)				
Number	Strength	Type	F.E.	Total	Number	Strength	Type	F.E.	Total
2	100%	Combined Arms Bn (29xM1, 29xM2, 3xM3)	1.79	3.58	2	100%	Armor Bn (44 x M1A2)	1.30	2.60
1	100%	Armed Recon Sqd (23 x M3, 12 x LRAS)	0.52	0.52	1	100%	Infantry Bn (44 x M2)	1.00	1.00
1	100%	155(SP) Bn (M109A6, 2x8) (PALADIN)	1.33	1.33	1	100%	155(SP) Bn (M109A6, 3x6)(Paladin)	1.50	1.50
	100%					100%			
	100%					100%			
		Friendly Force Equivalent		5.43			Friendly Force Equivalent		5.10
		Ratio of BCT to Legacy					Ratio of Friendly to Enemy		
		1.06:1					N/A		

Source: Created by author.

The similar force equivalent values between the heavy BCT and armor brigade demonstrate the concept of modularity and how combined arms units can make up for deficiencies in one area with superiority in others. When only singular systems are examined, the heavy BCT has two less 155mm systems (16) compared to the armor battalion with 18, an 11 percent reduction. When strictly comparing the difference in front line armor, (the M1A2), the heavy BCT has 30 less tanks compared to the legacy armor brigade, a deficit of 34 percent. If comparing individual weapon systems, the heavy BCT appears to be at a significant disadvantage to the legacy armor brigade in terms of tanks and artillery. However, as seen in the table above, taken as a whole, the heavy BCT has 11 percent more armored vehicles (M1A2, M2, M3) than the armored brigade. When the entire combined arms capability of the BCT is taken into account in terms of force equivalents, the combat power of the heavy BCT is actually 6 percent

greater. This comparison not only demonstrates the utility of the modularity concept, but that of the proposed joint model.

The comparison between the heavy BCT and armor brigade seems to disprove the assertions in chapter 1 that the modularity concept has left the Army with a significant deficit in firepower when viewed in totality and not by reductions in individual types of weapon systems. The impact of the modular BCT construct does becomes apparent however, when Stryker and infantry BCTs are compared to legacy brigades. While the heavy BCT could arguably be considered a replacement for, or modern version of, the armor brigade, Stryker and infantry BCTs are not as easily compared to legacy formations. Specialized light infantry brigades such as those in the 10th Mountain, 82nd Airborne and 101st Airborne divisions remain very similar to their pre-transformation predecessors, but the legacy mechanized infantry brigade does not have a modular BCT replacement in the exact sense. As a result, the Stryker and infantry BCTs are compared to a legacy mechanized infantry brigade. Though this is not a perfect comparison, it is designed to illustrate the larger impact of the overall force structure change and the compounding impact of firepower reductions. The first comparison shows a Stryker BCT compared to a legacy mechanized infantry BCT:

Table 8. SBCT--Mechanized Infantry Brigade Comparison

Force Ratios									
Friendly Forces (SBCT)					Friendly Forces (Legacy Mech Infantry)				
Number	*Strength*	*Type*	*F.E.*	*Total*	*Number*	*Strength*	*Type*	*F.E.*	*Total*
3	100%	SBCT Bn (Stryker x 53)	0.93	2.79	1	100%	Armor Bn (44 x M1A2)	1.30	1.30
1	100%	155(T) Bn (M198, 2x6)	0.70	0.70	2	100%	Infantry Bn (44 x M2)	1.00	2.00
	100%				1	100%	155(SP) Bn (M109A5, 3x6)	1.20	1.20
	100%					100%			
	100%					100%			
Friendly Force Equivalent				**3.49**	Friendly Force Equivalent				**4.50**
Ratio of BCT to Legacy					Ratio of Friendly to Enemy				
0.78:1					N/A				

Source: Created by author.

Here it is shown that the Stryker BCT possesses 22 percent less capability in the form of force equivalents than the legacy mechanized infantry brigade. Though arguably more mobile than the mechanized brigade, it clearly suffers in the areas of firepower and protection. The similarity of force equivalent values between the Stryker and infantry battalions in this case show the degradation in combat power is directly attributable to the lack of armor and reduction in artillery.

The comparison of the infantry BCT to the legacy mechanized infantry brigade provides the starkest example of decreased comparative capability. Again, while arguably an unfair comparison by itself, it goes to illustrate the potential combat power deficit in larger force packages or when facing a superiorly equipped enemy. The table below shows the comparison of these two units:

Table 9. IBCT--Mechanized Infantry Brigade Comparison

Force Ratios									
Friendly Forces (IBCT)					Friendly Forces (Legacy Mech Infantry)				
Number	*Strength*	*Type*	*F.E.*	*Total*	*Number*	*Strength*	*Type*	*F.E.*	*Total*
3	100%	Infantry Bn (Light)	0.40	1.20	1	100%	Armor Bn (44 x M1A2)	1.30	1.30
1	100%	105(T) Bn (M119, 2x8)	0.67	0.67	2	100%	Infantry Bn (44 x M2)	1.00	2.00
	100%				1	100%	155(SP) Bn (M109A5, 3x6)	1.20	1.20
	100%					100%			
	100%					100%			
Friendly Force Equivalent				**1.87**	Friendly Force Equivalent				**4.50**
Ratio of BCT to Legacy					Ratio of Friendly to Enemy				
0.42:1					N/A				

Source: Created by author.

Clearly the IBCT is at a distinct disadvantage because of the significant deficit in protection with no main battle tanks or even infantry fighting vehicles. The firepower deficit is also significant because not only does the IBCT lack the firepower of the 120mm and 25mm guns of the M1A2 and M2, but possesses fewer howitzers of lower caliber (105 mm vs 155mm) that also lack mobility (towed vs self-propelled). All of these factors lead to the IBCT having 58 percent less combat power than the legacy mechanized infantry brigade.

The actual impact of the cumulative reduction in firepower and protection in the BCTs when compared to legacy brigades is not appreciable until put into the context of the larger context of Army transformation and the total numbers and types of BCTs compared to previous force structure.

Table 10. Army Force Structure Comparison

1997 Force				2011 Force			
Type	Active	Reserve	Total	Type	Active	Reserve	Total
Armor Bde	6	7	13	HBCT	18	7	25
Mech Bde	9	13	22	SBCT	6	1	7
IN Bde	15	20	35	IBCT	23	20	43
Cav Regt	2	1	3	ACR	1	0	1
Total BDEs	32	41	73	Total BCTs	48	28	76

Source: John R. Brinkerhoff, "The Brigade-Based New Army" *Parameters*, no. 3 (Autumn 1997): 65.

There are a number of specific comparisons of note when looking at the number and types of brigades in 1997 compared to the projected end state of the Army modularity concept and conversion to BCTs.

First, the total number of maneuver brigades is increased from 73 to 76. Without accounting for the changes within the brigade structure under the BCT construct, it appears that the available maneuver force pool has increased, not only in overall size, but with a substantial shift in the number of active brigades compared to the number in the reserve component. This is misleading without taking into account there are fewer maneuver battalions in the HBCT and IBCT for example. Where the armor brigade was composed of two armor battalions and one mechanized infantry battalion, the HBCT has two CABs and one armed reconnaissance squadron. The IBCT is similar in that it only has two infantry battalions and one reconnaissance squadron. The other major difference between the two brigade constructs is the composition of the fires battalion. As discussed earlier in the chapter, the BCT has two less gun systems in the fires battalion when compared to the legacy brigade. These differences have led to some claims that the

number of BCTs is misleading because it does not highlight the decreases in these areas. An Institute for Defense Analysis report specifically highlighted the reduction in maneuver battalions, reporting a decrease of 30 percent.[1] The Army disputes the correlation to lack of capability, pointing out that the capability of the armed reconnaissance squadrons is not taken into account.[2] The previous comparison of the HBCT and the legacy armored brigade in table 7 appears to support the Army's claim. However, the decreased comparative capabilities of the SBCT and IBCT require the total force structure to be examined as a whole.

When examining the numbers and types of BCTs compared to legacy brigades, the first thing apparent is the increase in "heavy" units with the new force structure; almost double the HBCTs compared to armored brigades. There is also an increase in IBCTs, nearly a 23 percent increase. There is an apparently significant cost to these increases in the middle of the force structure, previously occupied by the mechanized infantry brigade, the closest comparison in the modular structure being the SBCT. With less than one third of the numbers of brigades, this is a significant decrease in combat power. To best capture the overall impact of these changes, the joint model is used to evaluate relative combat power between the legacy and modular force structures. For this evaluation, the infantry brigade and IBCTs are considered an even exchange and cancel each other out, leaving a delta of +8 IBCTs. The values for each BCT and brigade are the ones calculated in earlier examples in this chapter.

Table 11. Modular--Legacy Brigade Comparison

BCT Unit Type	Force Equivalent	Legacy Unit Type	Force Equivalent
HBCT (25 @ 5.43)	135.75	Armor (13 @ 5.10)	66.30
SBCT (7 @ 3.49)	24.43	Mech (22 @ 4.50)	99.00
IBCT (8 @ 1.87)	14.96		
BCT Total	175.14	Legacy Total	165.30

Source: John R. Brinkerhoff, "The Brigade-Based New Army" *Parameters*, no. 3 (Autumn 1997): 65.

The results of the comparison shows the modular construct possessing a small combat power advantage of 6 percent over the legacy force structure. This would appear to validate the argument that some of the decreases in armor and artillery have been accounted for with other systems and capabilities, even in a numerical analysis where elements of superior training and leadership are not accounted for.

Modular Force--Peer Competitor Comparison

The next step in determining if any combat power deficits exist in the BCT and will subsequently require direct support of air power is to run force correlation analyses on potential enemies in an MCO through the proposed integrated model. Not only will this quantify the combat power and force ratio deficiency if it exists, but it will also identify the required air support to fill deficiencies or meet required ratios based on the selected operation. The first example examines the heavy BCT executing an attack against a prepared theoretical peer competitor that is organized and equipped similarly:

Table 12. HBCT Versus Peer Competitor Brigade

HBCT vs Peer Competitor									
HBCT					Peer Competitor				
Number	Strength	Type	F.E.	Total	Number	Strength	Type	F.E.	Total
2	100%	Combined Arms Bn (29xM1, 29xM2, 3xM3)	1.79	3.58	2	100%	Tank Bn (MIB 40xT90)	1.06	2.12
1	100%	Armed Recon Sqd (23 x M3, 12 x LRAS)	0.52	0.52	1	100%	Infantry Bn (BMP-3)	0.65	0.65
1	100%	155(SP) Bn (M109A6, 2x8) (PALADIN)	1.33	1.33	1	100%	2S19 Bn	1.35	1.35
	100%					100%			
		Friendly Force Equivalent		**5.43**			Enemy Force Equivalent		**4.12**
		Ratio of Friendly to Enemy					Ratio of Enemy to Friendly		
		1.32:1					0.76:1		

Source: Created by author.

At first glance, there appears to be no issue when the HBCT contacts an enemy armor formation. The HBCT enjoys a combat power advantage of 32 percent over the enemy brigade. However, when using the historic minimum planning ratios from FM 5-0 discussed earlier in the chapter, the recommended minimum force ratio should be 3 to 1 where the HBCT in the example only possesses a 1.32 to 1 advantage. To achieve this 3 to 1 ratio, the HBCT force equivalent must be at least 12.36 or 3 to 1 compared to the enemy force equivalent of 4.12. This leaves the HBCT in this example short 6.93 force equivalents. This deficit can be filled in a number of ways in reference to the proposed joint model. It could be met with an additional combat aviation brigade and two Paladin battalions or an additional combined arms battalion and combat aviation brigade. The combinations are almost limitless. For the purpose of this project, the amount of direct support air power required to meet required force ratios for the attack will be specifically

examined. To do this, the converted force equivalents for each Air Force unit previously calculated are used and broken down further by sortie for each aircraft type:

Table 13. AF Aircraft Force Equivalents per Sortie and Unit

A/C Type	Daily Sorties	FE per unit	FE per sortie
A-10C (18)	26.1	3.20	0.12
A-10C (24)	34.8	4.27	0.12
F-15E (18)	19.26	3.25	0.17
F-15E (24)	25.68	4.33	0.17
F-16C (18)	21.96	1.82	0.08
F-16C (21)	25.62	2.13	0.08
F-16C (24)	29.28	2.43	0.08
B-1B (12)	7.2	3.38	0.47
B-52H (8)	4.8	2.89	0.60
B-52H (12)	7.2	4.33	0.60
AH-64D (24)	34.8	5.00	0.21

Source: Created by author.

Using this calculation, the number of direct support sorties the BCT requires or which type of Air Force unit needs to be made DS to the BCT can either determined. Though the Air Force does not align specific units to the Army in any capacity such as DS, GS or GSR, this analysis at the unit level allows for force requirements at a higher level to be easily quantified. Just like the multiple variations available discussed earlier, the combinations of fixed-wing air support that could potentially fill this gap are also almost limitless. In the above example, 56 sorties of A-10s, 84 sorties of F-16s or 12

sorties of B-52s or any number of combinations of the three could allow the BCT to meet its required force ratios. Put into terms of Air Force units, the BCT would require the combined support of all sorties generated by a 24 PAA A-10 and 8 PAA B-52 squadron to meet force ratios and fill firepower and protection deficiencies. While this may seem to be an extremely high number of aircraft, it is important to recall the assumptions for this comparison: a peer competitor at 100 percent strength, one brigade versus another. Another way to put this requirement into perspective is to look at similar force equivalents:

Table 14. BCT and AF Equivalent Units

Army Unit	Force Equivalent	AF Unit	Force Equivalent
Combined Arms BN	1.79	F-16C (18 PAA)	1.82
Armored Cav SQ	2.80	B-52H (8 PAA)	2.89
MLRS BN	4.50	F-15E (24 PAA)	4.33

Source: Created by author.

These similar force equivalent ratings illustrate one method of envisioning how fixed-wing air assets fit within the modularity concept. Though certain Air Force units have similar combat power to certain Army battalions, it would be incorrect to draw the conclusion that fixed-wing squadrons are equivalent to battalions. While this is true in the examples shown above, it is dependent on aircraft type and squadron size. Another

example illustrates a situation where one could draw the conclusion that fixed-wing units are more similar to a brigade in terms of firepower than a battalion:

Table 15. Army Force Equivalents Compared to AF Force Equivalents

Army Unit	Force Equivalent	AF Unit	Force Equivalent
Heavy BCT	5.43	F-15E (24 PAA)	4.33
Stryker BCT	3.49	B-1B (12 PAA)	3.38
Infantry BCT	1.87	F-16C (18 PAA)	1.82

Source: Created by author.

When compared to the combat power of the BCTs, a number of fixed-wing unit types are comparable to the combat power generated by the SBCT and IBCT. There are no fixed-wing units that produce as much combat power as the HBCT, though the larger variants of the A-10C and F-15E squadrons come closest, generating about 80 percent of the combat power of the HBCT.

Air Force Modernization Impacts

The challenges the Air Force currently faces with regards to force structure are being driven by very different forces than those driving Army transformation. There are a number of parallels when opening the discussion to the Army's FCS program, but for the purposes of this paper, comparisons will be limited to the changes involved with modularity and the BCT construct. The Army move to modularity, as discussed in chapters 1 and 2, is driven by the goal of creating units with greater mobility and agility

that can be easily tailored to meet the requirements of the environment they are deployed into. Modernization requirements, both good and bad, are driving the Air Force to change its force structure. As discussed in chapters 1 and 2, the Air Force faces an aging fleet and reduced budgets for acquiring new systems. Unfortunately, aging and fatigued airframes are outpacing the acquisition of new systems, resulting in the looming "fighter gap" previously discussed. The impact of the aging fleet has so far been confined to discussions on the Air Force's capability to execute its primary missions and very little on the second-order effects on the other services, specifically the Army's requirements for fixed-wing air support. Similar to the reductions in armor and artillery the Army is experiencing with modularity, the reduction in numbers of aircraft the Air Force is projecting is difficult to grasp without putting it into context. This context is provided by using the proposed integrated model. The currently proposed force structure for fiscal year 2010 (FY10) is shown below in table 16.

Table 16. FY10 Air Force Aircraft

Aircraft	Active	Guard	Reserve	Total
A-10C	114	78	24	216
F-15E	138	0	0	138
F-16	324	261	48	633
B-1B	36	0	0	36
B-52H	36	0	8	44

Source: U.S. Air Force Air Combat Command, Spreadsheet: "USAF Forces FY10 working," March 2009.

Alone, the total number of aircraft offers little insight to the combat capacity the Air Force currently possesses. Before putting these numbers into context using the integrated model, a quick comparison to the number of aircraft deployed in support of Operation Desert Storm offers a great deal of insight as shown in table 17.

Table 17. USAF Aircraft Deployed for Desert Storm

A-10	132
F-15E	48
F-16	247
B-1B	0
B-52H	66

Source: U.S. Government Accounting Office, "Operation Desert Storm: Evaluation of the Air Campaign" (Washington, DC: Government Printing Office, June 1997), 75.

Of note, more A-10s were deployed than in the current total active duty Air Force inventory, 75 percent of the current active F-16 force was deployed, and 1.5 times more B-52s were deployed than in the active, Guard and Reserve force total today. Furthermore, the proposal to retire 177 F-16s discussed in chapter 2 is not included in the FY10 totals, so that would represent a further decrease of 28 percent in the total number of F-16s across the active, Guard and Reserve.

Using the proposed integrated model, Air Force squadrons can be converted to Army force equivalents to calculate the total force equivalent or combat power of all 5 platforms, shown in table 18.

Table 18. AF Unit Force Equivalents

A/C Type	PAA	#SQ	Army Force Equiv	Total FE
A-10C	18	4	3.20	12.80
A-10C	24	6	4.27	25.60
F-15E	18	1	3.25	3.25
F-15E	24	5	4.33	21.67
F-16C	18	16	1.82	29.19
F-16C	21	5	2.13	10.64
F-16C	24	10	2.43	24.32
B-1B	12	3	3.38	10.15
B-52H	8	1	2.89	2.89
B-52H	12	3	4.33	13.00
Total Force Equivalents				153.52

Source: U.S. Air Force Air Combat Command, Spreadsheet: "USAF Forces FY10 working," March 2009.

The total force equivalent capability of the Air Force is important when compared to the total combat power potential of all Army BCTs shown previously in table 11. This is significant when considering the historic recommended force ratios discussed earlier in the chapter which typically call for a 3:1 force ratio advantage for a deliberate attack. This shows that the Air Force has the potential combat power of 88 percent of the total Army BCT force structure. It is important to note that this combat power value is for every platform in the active, Guard and Reserve components in the Air Force that could possibly be employed and does not take into account any of these multi-role platforms apportioned to other missions such as interdiction, counter-air, or strategic attack. The potential impact of these additional mission requirements will be discussed in further detail in chapter 5.

Modified Case Study: VII Corps Versus the Tawakalna Division

To put the proposed integrated model into a practical application and to better fuse available data to make a determination on requirements and the assets available to meet them, Operation Desert Storm will be used as an example. In the first part, the actual friendly and enemy forces at the start of the ground war will be compared using the integrated model. The second part will take the same forces, but will use BCTs in place of legacy brigades and change the enemy force to a peer competitor. The second part will examine the enemy at two different strengths; one similar to the start of the Desert Storm ground campaign where the enemy had been subjected to a dedicated and prolonged air campaign and one where the enemy is at full strength. To focus the scope of this example, the area and forces considered will be limited to the area of operations of the U.S. Army's VII Corps. The battle selected as the baseline for this application is the VII Corps destruction of the Tawakalna Mechanized Division, otherwise known as the Battle of the 73rd Easting. The Tawakalna Division protected the western approach into Kuwait. The ensuing battle involved three U.S. divisions and an armored cavalry regiment against one of the most powerful divisions of the Iraqi Army.[3] This battle involved some of the lowest force ratios of the Desert Storm ground war with close to a 1:1 force ratio in terms of maneuver battalions.[4] This ratio of course did not account for the superiority of U.S. weapons systems. Table 19 shows the force correlation calculation between VII Corps and the Tawakalna Division.

Table 19. VII Corps--Tawakalna Division Comparison

Desert Storm Force Ratios									
VII Corps					Tawakalna Mechanized Division(+)				
Number	Strength	Type	F.E.	Total	Number	Strength	Type	F.E.	Total
10	100%	Armored Cav Squadron	2.80	28.00	2	80%	Tank Bn (MIB 40xT64 / T72)	0.89	1.42
6	100%	Armor Bn (44 x M1A1)	1.24	7.44	3	80%	Tank Bn (TB 31xT64 / T72)	0.69	1.66
3	100%	Infantry Bn (44 x M2)	1.00	3.00	1	80%	Tank Bn (MIB 40xT55/62)	0.77	0.62
1	100%	155(SP) Bn (M109A5, 3x6)	1.20	1.20	2	80%	Tank Bn (TB 31xT55 / T62)	0.60	0.96
	100%				7	80%	Infantry Bn (32 x BMP-1 / 2)	0.51	2.86
	100%				3	80%	Infantry Bn (32 x BTR-50 / 60)	0.29	0.70
	100%				3	80%	2S1 Bn	0.90	2.16
	100%				1	80%	BM 21 Bn	3.15	2.52
Friendly Force Equivalent				**39.64**	Enemy Force Equivalent				**12.89**
Ratio of Friendly to Enemy					Ratio of Enemy to Friendly				
3.08:1					0.33:1				

Source: Stephen A Bourque, "*Jayhawk!: The VII Corps in the Persian Gulf War* (Washington, D.C.: Department of the Army, 2002), 326.

When the Desert Storm ground campaign commenced on 24 February 1991, the Iraqi Army had been subjected to attacks from the air for 39 days.[5] During this time, units arrayed along the Saudi border were subjected to the heaviest bombardment, resulting in force strengths below 50 percent by the start of the ground war.[6] In one case, air interdiction coupled with artillery reduced one Iraqi armored brigade to less than 10 percent effectiveness when the VII Corps Commander, LTG Franks demanded that the Iraqi unit "go away."[7] The air campaign was charged with reducing Iraqi fielded forces to 50 percent strength in order to achieve favorable force ratios for coalition ground forces.[8]

The next step in this practical application of the integrated model is to convert the historical example from Desert Storm to a modern context. To do this, VII Corps legacy brigades are replaced with BCTs and the Iraqi Tawakalna Division with a peer

competitor and associated equipment. VII Corps brigades from 1st Infantry Division, 1st Armor Division and 3rd Armor Division were all replaced with HBCTs. The 2nd Armored Cavalry Regiment (ACR) was left unchanged with three armored cavalry squadrons. Iraqi brigades were upgraded based on equipment type. Armor battalions equipped with T-72s were replaced with T-90s and T-55/T-62 battalions replaced with T-80s. For the mechanized infantry battalions, those equipped with BMP-1/2s were replaced with BMP-3s and BTR-50/60s were replaced with BMP-1s. Artillery was also updated and upgraded. In the first correlation, enemy forces were attrited to the same level as the start of the Desert Storm example:

Table 20. BCT--Peer Competitor Comparison

BCT-Peer Competitor MCO with Air Campaign									
BCT					Peer Competitor				
Number	Strength	Type	F.E.	Total	Number	Strength	Type	F.E.	Total
3	100%	Armored Cav Squadron	2.80	8.40	2	80%	Tank Bn (MIB 40xT90)	1.06	1.70
10	100%	Combined Arms Bn (29xM1, 29xM2, 3xM3	1.79	17.90	3	80%	Tank Bn (TB 40xT90)	1.06	2.54
5	100%	Armed Recon Sqd (23 x M3, 12 x LRAS)	0.52	2.60	1	80%	Tank Bn (MIB 40xT80)	1.00	0.80
6	100%	155(SP) Bn (M109A6, 2x8) (PALADIN)	1.33	7.98	2	80%	Tank Bn (TB 31xT80)	0.78	1.25
	100%				7	80%	Infantry Bn (BMP-3)	0.65	3.64
	100%				3	80%	Infantry Bn (32 x BMP-1 / 2)	0.51	1.22
	100%				3	80%	2S19 Bn	1.35	3.24
	100%				1	80%	2S3 Bn	1.05	0.84
		Friendly Force Equivalent		**36.88**			Enemy Force Equivalent		**15.23**
		Ratio of Friendly to Enemy					Ratio of Enemy to Friendly		
		2.42:1					0.41:1		

Source: Created by author

When compared to the historical example, the correlation above shows the modular force with a 21 percent reduction in its force ratio advantage over the enemy force, resulting in less than the desired 3:1 advantage. There are a number of factors of note in this comparison that are interesting when determining the contributing factors for the decrease in the friendly advantage. First, the enemy force equivalent increased by 18 percent when equipped with modern equipment, even though the total number of battalions remained the same (22). Meanwhile, the friendly force equivalent decreased by 7 percent despite apparent gains in equipment modernization as well (M1A2, M3, and M109A6). Also, in the BCT-equipped force, there are a total of 24 battalions (or squadrons) compared to only 20 in the VII Corps force structure. What appears to be another significant advantage for the BCT force is 5 additional artillery battalions compared to the VII Corps force. Despite all of these perceived advantages, the BCT equipped force loses a significant amount of its advantage over the enemy in this example due to a decrease in armor.

This correlation also allows the requirement for fixed-wing air support to be quantified in order to meet the desired 3:1 force ratio. Based on the force equivalents above, the BCT-equipped force requires an additional 8.81 force equivalents to meet the desired level of 45.69 (triple the enemy force equivalent). Returning to the force equivalent chart for fixed-wing aircraft on page 36, there are a vast number of combinations of sorties and/or units that will meet this requirement. Tables 21 and 22 below show the total sorties required by each type of aircraft as well as the number of squadrons to achieve the required force equivalent.

Table 21. Sorties Required

Aircraft	Sortie FE	FE Reqd	Sorties Reqd
A-10C	0.12	8.81	71.84
F-15E	0.17	8.81	52.20
F-16C	0.08	8.81	105.27
B-1B	0.47	8.81	18.76
B-52H	0.60	8.81	14.64

Source: Created by author

Table 22. Units Required

Unit	Unit FE	FE reqd	Units Reqd
A-10C (18)	3.20	8.81	2.75
A-10C (24)	4.27	8.81	2.06
F-15E (18)	3.25	8.81	2.71
F-15E (24)	4.33	8.81	2.03
F-16C (18)	1.82	8.81	4.83
F-16C (21)	2.13	8.81	4.14
F-16C (24)	2.43	8.81	3.62
B-1B (12)	3.38	8.81	2.60
B-52H (8)	2.89	8.81	3.05
B-52H (12)	4.33	8.81	2.03

Source: Created by author

The Air Force units and sorties require put the force equivalent gap into perspective, illustrating exactly how much it takes to go from almost a 2.5:1 ratio to 3:1. For example, you would need the support of 3 B-1B squadrons, which as seen previously in table 18, is the entire Air Force B-1B fleet. Translated into 18 PAA F-16 squadrons, the deficit would require the support of 5 squadrons, more 18 PAA squadrons than the active

Air Force possesses. While at first glance the force equivalent deficit for the BCT-equipped force to achieve a 3:1 advantage appears relatively small, but the integrated model shows it requires a significant commitment in apportionment from the Air Force to achieve.

The final comparison in this case study is to examine the second correlation without enemy attrition as a result of a dedicated air campaign prior to friendly ground forced crossing the line of departure. In this example, the forces and equipment remain exactly the same; the only change is in the enemy force strength is increased from 80 percent to 100 percent.

Table 23. BCT--Peer Competitor Comparison (No Air Campaign)

BCT-Peer Competitor MCO Force Ratios No Air Campaign									
BCT					PEER COMPETITOR				
Number	*Strength*	*Type*	*F.E.*	*Total*	*Number*	*Strength*	*Type*	*F.E.*	*Total*
3	100%	Armored Cav Squadron	2.80	8.40	2	100%	Tank Bn (MIB 40xT90)	1.06	2.12
10	100%	Combined Arms Bn (29xM1, 29xM2, 3xM3)	1.79	17.90	3	100%	Tank Bn (TB 40xT90)	1.06	3.18
5	100%	Armed Recon Sqd (23 x M3, 12 x LRAS)	0.52	2.60	1	100%	Tank Bn (MIB 40xT80)	1.00	1.00
6	100%	155(SP) Bn (M109A6, 2x8) (PALADIN)	1.33	7.98	2	100%	Tank Bn (TB 31xT80)	0.78	1.56
	100%				7	100%	Infantry Bn (BMP-3)	0.65	4.55
	100%				3	100%	Infantry Bn (32 x BMP-1 / 2)	0.51	1.53
	100%				3	100%	2S19 Bn	1.35	4.05
	100%				1	100%	2S3 Bn	1.05	1.05
		Friendly Force Equivalent		**36.88**			Enemy Force Equivalent		**19.04**
		Ratio of Friendly to Enemy					Ratio of Enemy to Friendly		
		1.94:1					0.52:1		

Source: Created by author

With no changes to the friendly forces, the significant shift in force ratios is entirely based on the increase in enemy strength. This increase results in a 25 percent increase in the enemy force equivalent and a decrease of 20 percent in the friendly force ratio advantage compared to the previous example. Again, while the 20 percent decrease does not seem significant by itself, it is not until translated into required support that the impact of a full-strength enemy can be appreciated. To achieve a 3:1 force ratio advantage, the friendly force now requires an additional 20.24 force equivalents, a 130 percent increase in fixed-wing air support requirements from the previous example. Again, tables 24 and 25 below translate these requirements into sorties and squadrons for the Air Force.

Table 24. Sorties Required

Aircraft	Sortie FE	FE Reqd	Sorties Reqd
A-10C	0.12	20.24	165.05
F-15E	0.17	20.24	119.92
F-16C	0.08	20.24	241.84
B-1B	0.47	20.24	43.09
B-52H	0.60	20.24	33.63

Source: Created by author

Table 25. Units Required

Unit	Unit FE	FE reqd	Units Reqd
A-10C (18)	3.20	20.24	6.32
A-10C (24)	4.27	20.24	4.74
F-15E (18)	3.25	20.24	6.23
F-15E (24)	4.33	20.24	4.67
F-16C (18)	1.82	20.24	11.10
F-16C (21)	2.13	20.24	9.51
F-16C (24)	2.43	20.24	8.32
B-1B (12)	3.38	20.24	5.98
B-52H (8)	2.89	20.24	7.01
B-52H (12)	4.33	20.24	4.67

Source: Created by author

The scale of this increase becomes apparent when examining the required sorties and units the Air Force would be required to commit in support of the ground force in this example. Put in perspective, it would require the entire active Air Force bomber fleet to meet this requirement. For fighter aircraft it would require nearly 200 F-16s, 87 percent of the entire F-15E fleet, or every active duty Air Force A-10 squadron.

Through the use of the proposed integrated model and the modified case study, the impacts of Army transformation to modular BCTs and the Air Force's battle with modernization and an aging fleet are put into a context that illustrate the second order impacts on the other service and the results are sobering. When faced with an enemy force of just under 2 divisions, the Army will potentially call for a large portion of the Air Force's combat fleet to meet recommended historic force ratio requirements. The Army will clearly require more support in the future if faced with an MCO. In such a case, the

Air Force will be challenged to apportion sufficient fixed-wing support to the Army. There are a number of potential problems that can be extrapolated from the data and case study in this chapter. What size of force is the U.S. likely to face with a true peer competitor? How will a robust air defense capability impact the apportionment decision and subsequent fixed-wing air support available to support ground operations? Will continued operations in Iraq and Afghanistan exasperate equipment fatigue issues for both the Army and the Air Force? How will current budget recommendations impact this problem? All of these questions have the potential to significantly increase requirements and stress the forces of both services beyond what is illustrated in this chapter. Some of these impacts will be discussed in chapter 5.

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[1]Andrew Feikert, CRS Report for Congress, *U.S. Army's Modular Redesign: Issues for Congress* (Washington, DC: Government Printing Office, 2006), 3.

[2]Ibid., 4.

[3]Stephen A. Bourque, *Jayhawk!: The VII Corps in the Persian Gulf War* (Washington, DC: Department of the Army, 2002), 323.

[4]Ibid., 326.

[5]Diane T. Putney, *Airpower Advantage: Planning the Gulf War Air Campaign 1989-1991* (Washington, DC: Air Force History and Museums Program, 2004), 362.

[6]Richard M. Swain, *Lucky War: Third Army in Desert Storm* (Fort Leavenworth: U.S. Army Command and General Staff College Press, 1994), 226.

[7]Robert H. Scales, Jr., *Certain Victory: The U.S. Army in the Gulf War* (Washington DC: Brassey's, 1994), 191-192.

[8]Putney, *Airpower Advantage*, 229.

CHAPTER 5

RECOMMENDATIONS AND CONCLUSION

The Army and the Air Force are both undergoing large changes in their force structure as a result of transformation and modernization initiatives. These changes are producing second order effects on the other service and impact the interdependent relationship between the two services. The analysis presented in this paper does not allow for specific answers to these problems, but does allow some of these second order effects to be identified and quantified. The recommendations presented offer potential solutions to mitigate negative effects and a way ahead to prevent them from developing in the wake of future transformation and modernization efforts. The impact of recently announced Defense Department proposed cuts to the 2010 budget will be also briefly discussed. Finally, areas for further study will be identified to expand the discussion on some of the issues identified in this paper.

Findings

Research into service-specific modeling identified a trend of decreased emphasis on the use of mathematical or scientific models for identifying force and support requirements and a shift toward intangibles and operational art. As discussed in chapters 2 and 4, these intangibles included factors such as training, leadership, and skill to balance out any numerical inferiority in force ratios. Enhanced battlefield situational awareness (SA) through increased capabilities in command and control and datalink architecture is another intangible used to replace numerical force comparison. Both existing models and the integrated model proposed in this paper are not free from

intangibles when assessing comparative weights or values, but they do provide a more scientific methodology to examine force structure and conduct comparative analysis in an effort to quantify these requirements or capabilities. The integrated model clearly demonstrates that mathematical models remain useful in not only conducting hypothetical force comparisons as shown in the case study, but to quantify changes in force structure by comparing new systems or forces to legacy systems and forces.

When the integrated model was used to examine and quantify the impact of decreased amounts of organic armor and artillery in the BCTs on combat power potential, numerous items of interest were found. Concerns of decreased capability in the Army's heaviest units due to decreased maneuver battalions were disproven. HBCTs were found to be on par with the legacy armored brigade and actually have slightly more combat power. The SBCT was found to be at a deficit when compared against a legacy mechanized infantry brigade, but these results were not at all surprising or unexpected based on the different characteristics of the primary vehicles in each unit as well as the Stryker's ability to trade armor and firepower for increased mobility and SA. Significant deficits were not found when BCTs were compared against legacy brigades individually. However, when the Army force structure as a whole was examined, a broader problem was identified. While the total Army force structure at the completion of transformation to the modular BCTs is actually increasing the number of maneuver brigades, the types of brigades presents a potential issue in potential combat power when a large number of BCTs is employed simultaneously. The increase in HBCTs compared to legacy armor brigades is offset by the decrease in capability in the "middle" of the force, the legacy mechanized infantry brigade, now replaced by the SBCT. Not only were SBCTs found to

have 22 percent less combat power than the mechanized infantry brigade as shown in table 8, there were two thirds fewer SBCTs as shown in table 10. Chapter 4 illustrated that if an MCO-style conflict was large enough to require more than the 25 HBCTs in the entire Army, the available combat power drops significantly. Where mechanized brigades were employed in the past, the future may require IBCTs be employed instead based on forces available.

Firepower and armor deficits in the SBCT and IBCT support claims that the Army will become more reliant on Air Force fixed-wing support in the future, especially in larger conflicts, as discussed in chapters 1 and 2. The amount of fixed-wing air support required to achieve favorable force ratios in the analysis proved to be significant. Based on force equivalents calculated using the integrated model, BCTs required the support of multiple squadrons of aircraft when faced with a single peer-competitor brigade. Again, the magnitude of this requirement is not truly appreciated until put into the context of a larger force structure. In the aforementioned case, the HBCT was used. In light of previously discussed findings, this requirement is likely to grow or increase with the employment of SBCTs and IBCTs. When examining the force structure the Air Force is projecting for fiscal year (FY) 2010, there is less than a 1:3 ratio of Air Force combat squadrons to Army BCTs. If the requirement presented in the example of the single BCT or that used in the Desert Storm modified case study is extrapolated to a larger battle or conflict, it appears the Air Force will be unable to provide the Army sufficient direct fire support.

One of the assumptions not specifically discussed in the analysis portion of this paper has the potential to further amplify this problem. In the analysis of Air Force

aircraft combat power available, all of the platforms capable of conducting counterland missions were considered. What was not discussed was the issue of multi-role aircraft. The term multi-role in the context of this paper means aircraft capable of performing missions other than CAS, SCAR and KI short of the fire support coordination line (FSCL). For example, both the B-52 and B-1 are capable of conducting both interdiction and strategic attack in addition to SCAR and CAS. F-15Es can be tasked to perform counter-air and interdiction. F-16s train for and are routinely employed for interdiction, suppression of enemy air defense (SEAD), and counter-air. This becomes a significant issue when discussing MCO because phasing and timing of operations have significant impacts on the apportionment decision and the air forces available. If U.S. forces are faced with a peer competitor, the Air Force will doctrinally execute an air campaign focused on achieving general air superiority along with a strategic attack and interdiction campaign aimed at enemy centers of gravity and critical vulnerabilities. To accomplish these missions, many of the assets considered available to support the land component in the analysis portion of this paper will be tasked to other missions. For example, it is reasonable to assume that if land component were to commit forces without conducting an air campaign in advance, most, if not all of the B-52s, B-1s and F-15Es would be apportioned to strategic attack and interdiction missions, in support of JFC objectives and not in direct support of the land component. Furthermore, if the enemy were in fact a peer-competitor with a robust air defense system, a portion of the F-16 force (F-16CJ squadrons, specially trained for SEAD) would be tasked with SEAD and not counterland missions. If the conflict took place outside of the Korean peninsula, the squadrons there would likely be unavailable based on status of forces agreements, further curtailing Air

Force aircraft available. Based on these assumptions, Air Force fixed-wing aircraft available to support the BCTs drops significantly, from 54 squadrons to only 29. This represents nearly a 50 percent decrease in squadrons available and greater than 50 percent decrease in force equivalents and combat power as seen in tables 26 and 27 below.

Table 26. AF Force Equivalents Available--Active, Guard and Reserve

A/C Type	PAA	#SQ	Army Force Equiv	Total FE
A-10C	18	4	3.20	12.80
A-10C	24	6	4.27	25.60
F-15E	18	1	3.25	3.25
F-15E	24	5	4.33	21.67
F-16C	18	16	1.82	29.19
F-16C	21	5	2.13	10.64
F-16C	24	10	2.43	24.32
B-1B	12	3	3.38	10.15
B-52H	8	1	2.89	2.89
B-52H	12	3	4.33	13.00
Total Force Equivalents				153.52

Source: U.S. Air Force Air Combat Command, Spreadsheet: "USAF Forces FY10 working," March 2009.

Table 27. AF Force Equivalents Adjusted

A/C Type	PAA	#SQ	Army Force Equiv	Total FE
A-10C	18	4	3.20	12.80
A-10C	24	5	4.27	21.34
F-15E	18	0	3.25	0.00
F-15E	24	0	4.33	0.00
F-16C	18	12	1.82	21.89
F-16C	21	3	2.13	6.38
F-16C	24	5	2.43	12.16
B-1B	12	0	3.38	0.00
B-52H	8	0	2.89	0.00
B-52H	12	0	4.33	0.00
Total Force Equivalents				74.58

Source: U.S. Air Force Air Combat Command, Spreadsheet: "USAF Forces FY10 working," March 2009.

The impact of a decrease in available combat power to support the BCTs can be put into context by returning to the modified case study presented in chapter 4. In the third example where the BCTs faced a peer-competitor with no attrition due to airpower (100 percent strength), the required amount of force equivalents to meet the desired force ratio of 3:1 was 20.24. The friendly force in that example was composed of 18 maneuver battalions, or 6 brigades (1 ACR, 5 HBCTs). This force constitutes only 8 percent of the Army's total force of 76 BCTs. To meet the 20.24 required force equivalents, the Air Force would be committing 27 percent of its available force (based on apportionment assumptions in table 27) in direct joint fires support. If this example is linearly extrapolated, the Air Force could fall short in its capability to support the BCTs if the Army is faced with a force only 3-4 times larger, requiring a force in excess of 22 BCTs. This dilemma again raises the issue of the Army force structure and the increased support

requirements for the SBCTs and IBCTs. The case study involved only heavy units (HBCTs, ACR) and eventually, these finite resources will be exhausted and SBCTs and IBCTs must be employed. This will result in an even greater demand for fixed-wing air support and potentially deplete Air Force capabilities at an even greater rate.

Recent announcements by Defense Secretary Robert Gates in April 2009 regarding proposed cuts to the Defense Department's 2010 budget are cause for even greater concern as more assets are cut and the fighter gap continues to grow. Three items in particular have an immediate impact on the discussion in this paper. First, Secretary Gates announced the termination of the F-22 program at 187 aircraft, far below the Air Force's defined requirement for 381.[1] Though the F-22 is not designed to execute the counterland mission, the reduction has second order effects on the rest of the fleet. With fewer F-22s available to conduct counterair missions, more multi-role aircraft such as the F-15E and F-16 will likely be apportioned to that mission and be unavailable for CAS, SCAR or KI. In addition to halting the F-22 production, the early retirement of 250 fighter aircraft was announced.[2] This plan includes the retirement of 177 F-16s, the impacts of which were previously discussed in chapter 4. Finally, the cancellation of the Air Force's new bomber was also part of the budget cut proposal. The potential impact of this decision is difficult to quantify at this point, but it is reasonable to assume that both fatigue issues and the nuclear mission may result in far less B-52s available in the future as well.

Recommendations

Clearly, if nothing else, the research in this progress supports the recommendation that both the Army and the Air Force must work more closely together in making

decisions involving force structure based on the close interdependence the two services share. Currently, both services are undergoing changes that are affecting the other service without their clear knowledge and understanding of what they will be expected to do and provide in response. This is clear based on the fact that current decisions not only suffer from lack of coordination, but are diverging from a requirements and capabilities perspective. If the Army is going to decrease a capability in exchange for Air Force fixed-wing support, the Air Force needs to be aware and funded and equipped to meet the requirement. Conversely, if the Air Force is going to retire aircraft and decrease total capacity to provide support to the Army, this also needs to be communicated. If the two services continue to make these decisions in a vacuum and not consult the other service for potential impacts, the problem is likely to remain undiscovered until the failure of a future operation where flawed assumptions are applied on what one service is doing for the other.

The case study also clearly demonstrates the advantage and need for conducting independent air operations in advance of ground forces commencing with land operations. Based on the potential available forces in an MCO conflict, the Army is best served to set conditions in advance of conducting land operations through attrition of enemy forces via a preceding air campaign versus engaging the enemy at full strength. This issue is critical when considering the timing and tempo of an engagement or major operation.

Based on changes to both services' force structures, the Army must be very cognizant of the Air Force's capacity and impact on the apportionment recommendation. As illustrated in table 27, the Air Force's capacity to support the land component drops

significantly if CAS, SCAR and KI are required simultaneously with counterair, interdiction and strategic attack. This decision is not a single service's decision, but one that belongs to the JFC. The JFC will have to look very closely at the modular force the Army brings to the fight and compare it to what the Air Force is able to provide in support based on the scheme of maneuver. By employing the integrated model proposed in this paper, planners from both services can quickly identify, quantify and reconcile requirements and capacity. This will allow for the formulation of an effective and efficient integrated plan that maximizes the employment of joint fires in support of the land component.

The use of the integrated model in the analysis portion of this paper raises the issue of the current and future role of mathematical force ratio modeling in future planning. As discussed in chapter 2, current doctrinal trends show a decreased focus on mathematical models and more discussion of intangibles such as leadership, training and SA when executing a correlation of forces. While not infallible and subject to bias if improperly applied, this paper demonstrates that numerical-based models have a place in the planning process from the tactical level to the operational level. The integrated model allows for BCT staffs to analyze and quantify their requests for joint fires, whether it is additional artillery, attack aviation or fixed-wing CAS. Division-level planners can apply the model to determine how assets not organic to the BCTs should be allocated and how available CAS should be distributed. Air operations center (AOC) and air support operations center (ASOC) planning cells will be able to more accurately estimate the weight of effort based on anticipated requirements and requests to better focus planning, preparation and mission products. Planners at the JFLCC and JFACC level will have a

tool that will assist in making more accurate inputs to and recommendations for the apportionment decision to the JFC respectively. Finally, at the JFC level, planners and staffs can use the model to assist in determining force levels and building both requests for forces (RFF) and the time-phased force and deployment data (TPFDD) to support a particular plan or operation. Dismissing the use of numerical-based models and removing them from doctrine sets a dangerous precedent. The belief that factors such as superior training and leadership, technological advantages and information superiority will always make numerical force ratios irrelevant deprives planners and staffs at all levels of an important tool. It also reflects a negative western war fighting cultural bias. A relatively well known aphorism (frequently attributed to Joseph Stalin) states "quantity has a quality all its own." These words are very foreboding when considering a possible future MCO at a time when U.S. forces are shrinking and dealing with aging equipment.

Areas for Further Study

During the course of this study, numerous areas for future research became apparent. The most obvious areas in need of continued and expanded study are those involved with the delimitations and assumptions in this paper that were specifically invoked to keep the scope of this project limited. The next logical step in this analysis would be to examine the combat power available in the combat aviation and fires brigades. This capability would alleviate some of the requirements placed on Air Force fixed-wing assets in this study. Another area in need of additional analysis is the impact on the Air Force's capability to support the BCT with the introduction of the F-35 to the fleet and the previously mentioned "fighter gap" as legacy aircraft are retired and fewer F-35s replace them. A similar study of the Air Force and Army force structures projected

10 years from now could go a long way to identifying potential gaps in both capability and capacity requirements that could be addressed early enough to be remedied. Another area not considered in this study which is becoming a large part of AF force structure and capability is the unmanned aerial system (UAS). With many armed UAS platforms such as the MQ-1 Predator and MQ-9 Reaper, there is another growing force pool to potentially draw from outside of the platforms discussed here. Finally, a new, integrated force correlation model should be pursued by both services jointly that captures current capabilities (both friendly and enemy) and attempts to merge some of the intangible factors discussed previously into an accepted baseline and weighting system. Ideally, this model would go beyond the Army and Air Force and expand to all of the services, giving the JFC and components a very useful tool for planning.

Conclusion

The Army's transformation to the modular BCT has come with a loss of organic artillery and armor, resulting in the potential for an increased requirement for Air Force fixed-wing air support. In the same timeframe, the Air Force has dealt with significant fatigue and supportability issues with its aging fleet, resulting in accelerated force reductions. Combined, the force structure changes of the two services have resulted in a potential situation where Army requirements could outweigh the Air Force's capability to support. The findings of this paper show that when faced with a peer-competitor in an MCO-level conflict, the Air Force will be under great strain to support the BCT. The two services must increase a dialogue on current and future force structure decisions in an effort to identify areas of interdependence that are impacted as a second order effect of these decisions. The integrated model proposed in this paper offers both services a

starting point to examine and quantify these requirements and capabilities. As forces continue to be reduced and equipment continues to age in the coming years, this problem will only grow at an exponential rate if not addressed. In the counterland battle, the Army and Air Force cannot afford to wait until forces cross the line of departure to begin integrating. To be successful in the future, the two services must work to solve these problems now to increase the chances for success as a joint force in the future.

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[1]Erik Holmes, “Axing the Air Force,” *Air Force Times*, 20 April 2009.

[2]Ibid.

APPENDIX A

INTEGRATED FORCE RATIO CALCULATOR VALUES

INTEGRATED FORCE RATIO CALCULATOR			
Friendly		**Enemy**	
Type	**Force Equivalent**	**Type**	**Force Equivalent**
Infantry Bn (58 x M113)	0.71	Infantry Bn (32 x BTR-50 / 60)	0.29
Infantry Bn (44 x M2)	1.00	Infantry Bn (32 x BTR-70 / 80)	0.36
Infantry Bn (Light)	0.40	Infantry Bn (32 x BMP-1 / 2)	0.51
Infantry Bn (Airborne/Air Assault)	0.50	Infantry Bn (BMP-3)	0.65
-----		Infantry Bn (Light / Air Assault)	0.35
Armor Bn (44 x M1A1)	1.24	Infantry Bn (Airborne)	0.50
Armor Bn (44 x M1A2)	1.30	-----	
-----		Recon Bn	0.20
Armored Cav Regiment	11.40	AT Bn (12 x 2A45 & 6 x AT-5/6)	0.35
Armored Cav Squadron	2.80	AT Bn (IMIBn / AT Regt)	0.21
-----		-----	
105(T) Bn (M102, 3x6)	0.70	Tank Bn (MIB 40xT55/62)	0.77
105(T) Bn (M119, 3x6)	0.75	Tank Bn (MIB 40xT64 / T72)	0.89
155(SP) Bn (M109A5, 3x6)	1.20	Tank Bn (MIB 40xT80)	1.00
155(SP) Bn (M109A6, 3x6)(Paladin)	1.50	Tank Bn (MIB 40xT90)	1.06
155(T) Bn (M198, 3x6)	1.05	Tank Bn (TB 31xT55 / T62)	0.60
MLRS Bn (M270A2, 3x6)	4.50	Tank Bn (TB 31xT64 / T72)	0.69
ATACMS Bn (B2)	6.00	Tank Bn (TB 31xT80)	0.78
ATACMS Bn (B1)	10.00	Tank Bn (TB 40xT90)	1.06
-----		Indep Tank Bn (51xT55/62)	0.98
Div Cav Sqdn (AASLT Div) (32 x OH-58D)	4.10	Indep Tank Bn (51xT64 / T72)	1.13
Div Cav Squadron (Abn Div) (24 x OH-58D)	3.10	Indep Tank Bn (51xT80)	1.28
Div Cav Squadron (Lt Div) (16 x OH-58D)	2.10	Indep Tank Bn (51xT90)	1.36
Div Cav Squadron (Heavy Div) (16 x OH-58D)	3.80	-----	
-----		2A36 Bn	0.75
Atk Helo Bn (24 x OH-58D)	3.00	2A65 Bn	0.75
Atk Helo Bn (24 x AH-64)	5.00	2S1 Bn	0.90
-----		2S3 Bn	1.05
		2S5 Bn	1.13
Combined Arms Bn (29xM1, 29xM2, 3xM3)	1.79	2S7 Bn	1.28
Armed Recon Sqd (23 x M3, 12 x LRAS)	0.52	2S9 Bn	0.60
		2S19 Bn	1.35
SBCT Bn (Stryker x 53)	0.93	2S23 Bn	0.60
155(T) Bn (M198, 2x6)	0.70	9A51 Bn	3.78
		9A52 Bn	3.60
155(SP) Bn (M109A6, 2x8) (PALADIN)	1.33	BM 21 Bn	3.15
105(T) Bn (M119, 2x8)	0.67	BM 21V Bn	1.04
		BM 22 Bn	3.50
A-10C Sqdn (18 x A-10)	3.20	BM 24 Bn	1.60
A-10C Sqdn (24 x A-10)	4.27	D20 Bn	0.68
F-15E Sqdn (18 x F-15)	3.25	D30 Bn	0.60
F-15E Sqdn (24 x F-15)	4.33	FROG Bn	0.22
F-16C Sqdn (18 x F-16)	1.82	M46 Bn	0.68
F-16C Sqdn (21 x F-16)	2.13	M240 Bn	0.42
F-16C Sqdn (24 x F-16)	2.43	SCUD Bn	0.84
B-1B Sqdn (8 x B-1B)	3.38	SCUD-B Bn	0.42
B-52H Sqdn (8 x B-52H)	2.89	SS-21 Bn	0.63
B-52H Sqdn (12 x B-52H)	4.33	-----	
		Hind- D Bn (40)	3.30
		Hind-E Bn (40)	4.17
		HOKUM / HAVOK Bn (40)	5.83

Source: Created by author.

APPENDIX B

USAF COMBAT AIR FORCE (CAF) AIRPOWER BREAKDOWN

USAF CAF INVENTORY FY 10				
Aircraft	Active	Guard	Reserve	Total
A-10C	114	78	24	216
F-15E	138	0	0	138
F-16	324	261	48	633
B-1B	36	0	0	36
B-52H	36	0	8	44

F-16 CJ Sq		F-16 CJ airframes	
Active	ANG	Active	ANG
3 x 24	1 x 24	150	24
2 x 21			
2 x 18			

USFK		USFK airframes	
A-10	F-16	A-10	F-16
1 x 24	1 x 24	24	60
	2 x 18		

Active Duty Squadrons				
Aircraft	12 PAA	18 PAA	21 PAA	24 PAA
A-10C		1		4
F-15E		1		5
F-16		4	4	7
B-1B	3			
B-52H	3			

ANG + AFRC Squadrons				
Aircraft	8 PAA	18 PAA	21 PAA	24 PAA
A-10C		3		2
F-15E				
F-16		12	1	3
B-1B				
B-52H	1			

USAF Total Squadrons					
Aircraft	8 PAA	12 PAA	18 PAA	21 PAA	24 PAA
A-10C			4		6
F-15E			1		5
F-16			16	5	10
B-1B		3			
B-52H	1	3			

USAF Total Squadrons - Adjusted (F-15Es, F-16CJs, B-1s, B-52s, USFK removed)					
Aircraft	8 PAA	12 PAA	18 PAA	21 PAA	24 PAA
A-10C			4		5
F-15E			0		0
F-16			12	3	5
B-1B		0			
B-52H	0	0			

Source: U.S. Air Force Air Combat Command, Spreadsheet: "USAF Forces FY10 working," March 2009.

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